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SULPHUR

THE MAGAZINE OF WORLD SULPHUR

contents

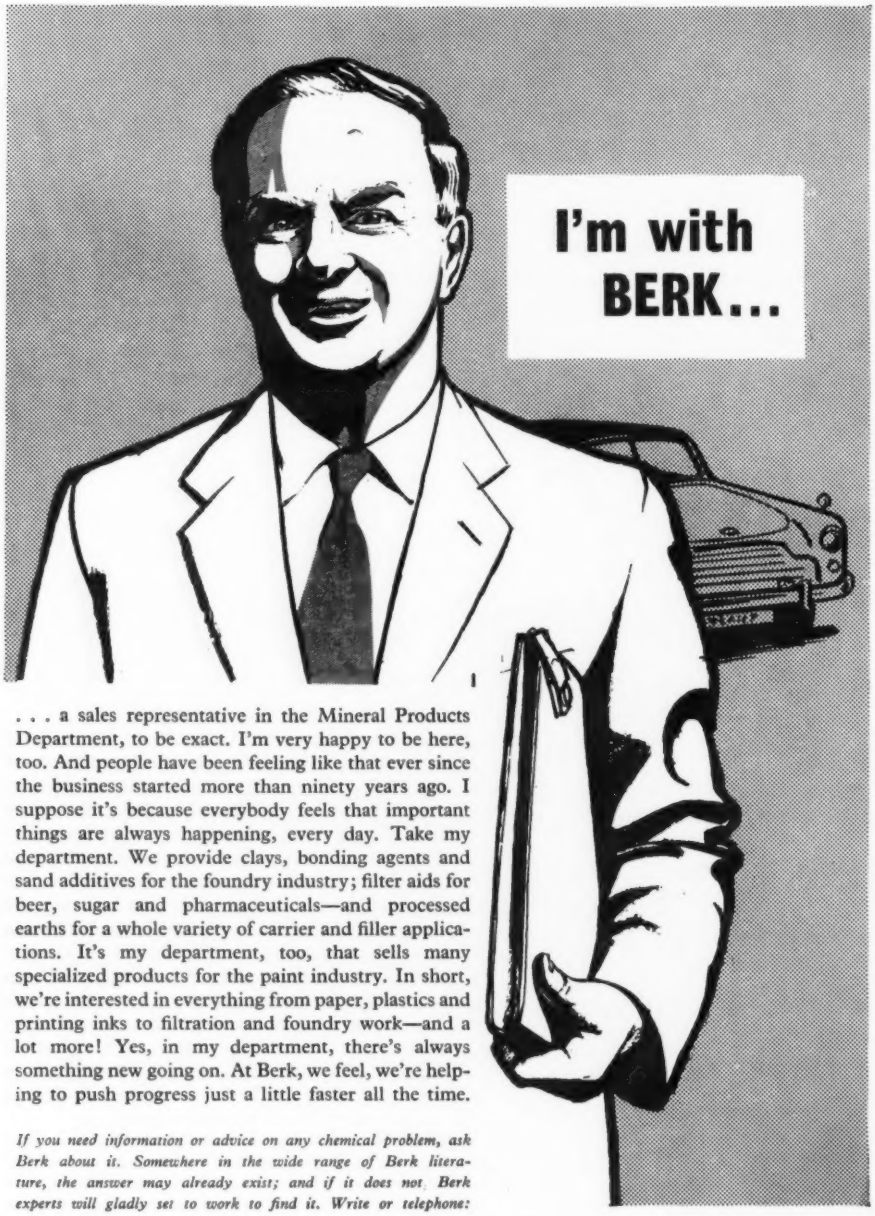
	page
Pyrites World Trade in 1960 Shows Good Recovery	1
Canada's Sulphur Production Increased 61.3% in 1960: Consumption in 1961 expected to be 1.1m. s. tons	7
Japan's Sulphuric Acid Production Up 6.1% in 1960: Notable expansion in detergent industry	12
Multi-hearth Steam Generation Furnaces for Pyrites: In operation at Farbenfabriken Bayer AG.	15
Prices and Trends: Pyrites in Europe Hold Sulphur Price Balance	19
Freights: In some sectors Demand for tonnage exceeds Supply	23
Sulphurex Continuous Sulphonation Process: Uses sulphur trioxide instead of oleum or other sulphonating agent	25
Expanding U.S. Sulphur Demand in Second Half 1961: But U.S. Frasch producers apprehensive about the future	29
Varga Process for Sulphur Removal	34
Pyrite Recovery from Old Mill Tailings: Denver flowsheet study	35
Montecatini's Major Pyrites Acid Plant at Follonica: Will include two de Nora-Monsanto H_2SO_4 units	37

CURRENT EVENTS

Canada	Molten Sulphur from Innisfail	38
	Sweetening Process on Trial	38
India	Travancore Titanium Expansion Scheme	38
United States	Research on Continuous Sulphite Pulping	39
	American Cyanamid Expand Phosphate Production	39
	Liberation of Beryllium by Sulphuric Acid	39
Norway	Orkla Gruve Sulphur Exports	39
Austria	Decline in Use of Spent Oxide	40
	Steirische Chemie's CS_2 Production Falls	40
U.S.S.R.	Sulphur and Acid Industry Developments	40
Poland	Natural Gas Deposits	40

COMPANY REPORTS

Jefferson Lake Sulphur Company Reduced Sulphur Sales During First Half 1961	41
Gulf Sulphur Corporation Has Increased Sulphur Production	41
Montecatini Curtailed Sulphur Production in 1961 But Increased Output of Pyrites	42
Snia Viscosa's Results Reflect Transformation in Operations	42
S.N.P.A. Exported Over Half of 1960 Sulphur Output	43
Ets. Kuhlmann's Sulphuric Acid Facilities Satisfactory Operations	44
Algemene Kunstzijde Unie Reports Booming Rayon Tyre Cord Demand in 1960	44
Statistical Appendix	46
Index to Advertisers	xxi



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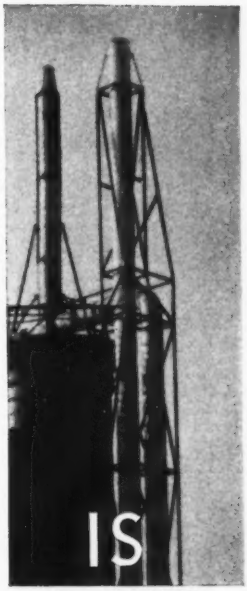

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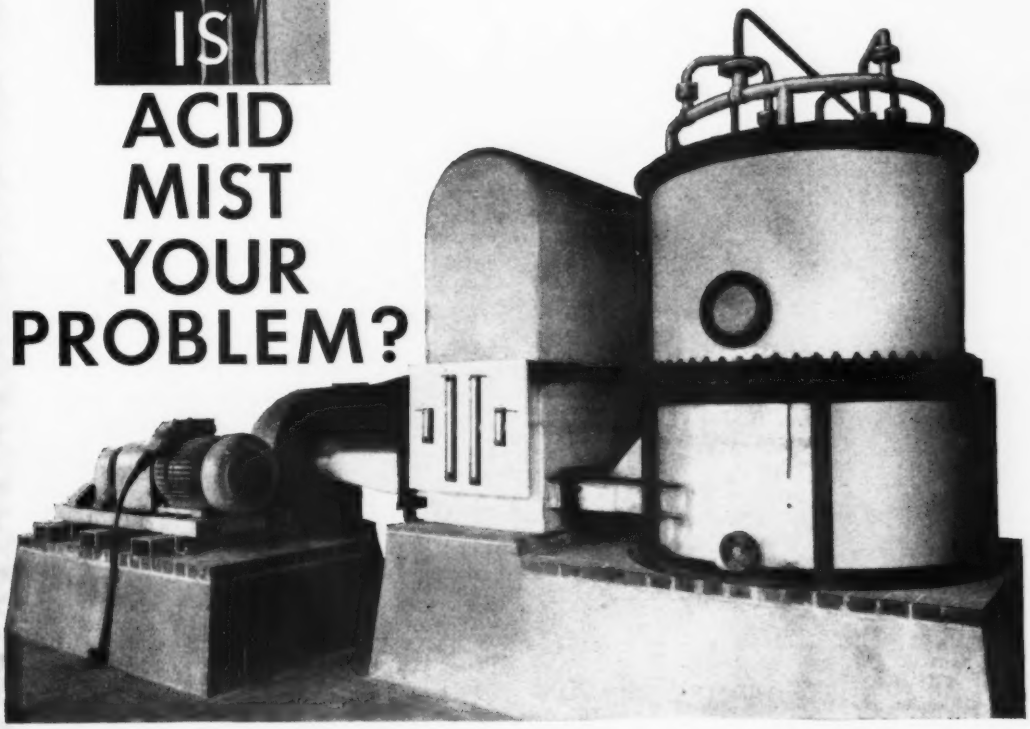

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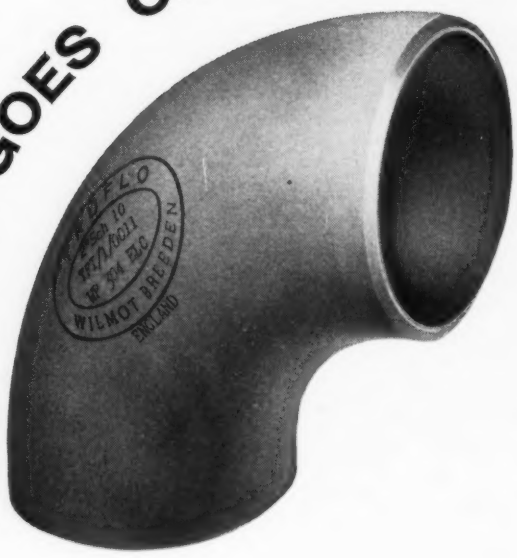

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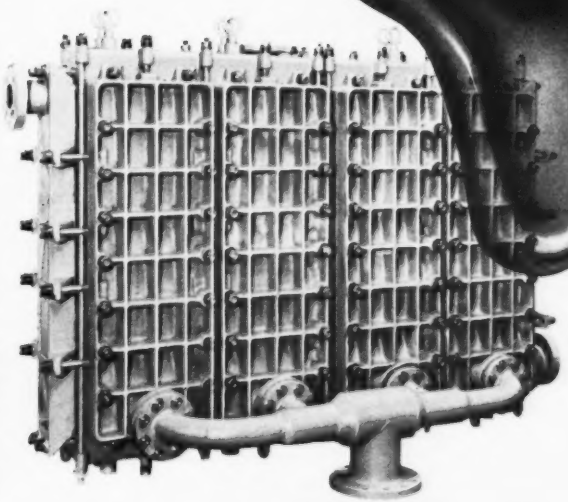

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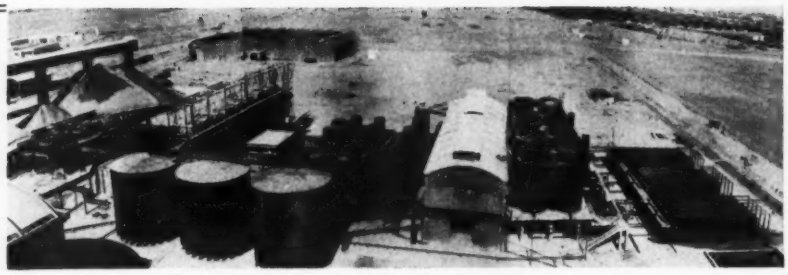

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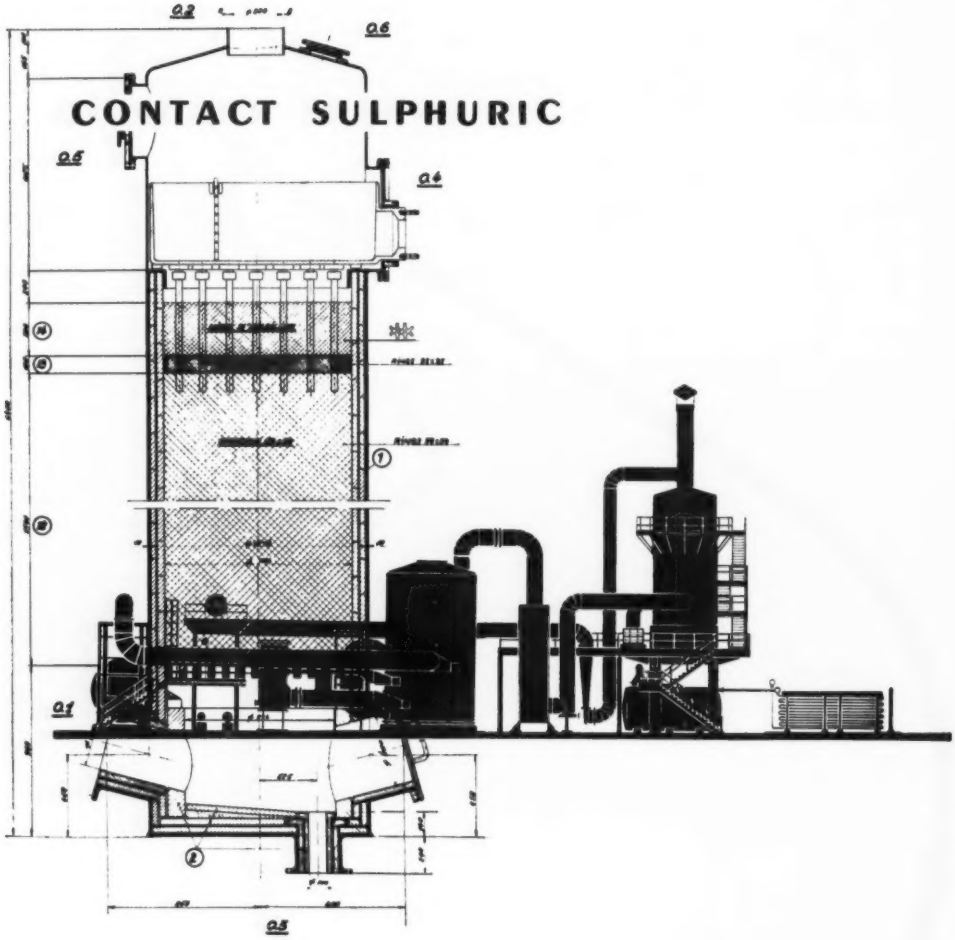

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Pyrites World Trade in 1960 Shows Good Recovery

WORLDWIDE expansion of sulphur demand in 1960 boosted exports of pyrites to 4.36 million tons (2.07 million tons sulphur content) reversing the recessionary trend in 1959 and raising the level of pyrites trade 5.8% above that in 1958. World trade of sulphur in all forms which except for negligible quantities of spent oxide and sulphur filter cake is represented by shipment of brimstone and pyrites, totalled 5.7 million tons S in 1960 of which pyrites accounted for 36.4%. In addition to the trade figures outlined above the U.S.S.R. supplies pyrites to East Germany, estimated at 350,000 tons a year. Of the world exports of pyrites 92.2% originated from seven countries — Spain, Cyprus, Norway, Canada, Portugal, Yugoslavia and Italy — of which Spain remained the largest, accounting for 29.6%.

European Producers

In contrast to world brimstone exports, of which only 17.5% originated in Europe, the share of world trade of European producers of pyrites is nearly 93%. The bulk is directed to consumers in Northern and Western Europe and shipments to Eastern European countries and to Africa totalled only about 164,000 tonnes. Outside Europe the only exporters, now that Southern Rhodesia has ceased shipping to the Republic of South Africa, were Cuba and Canada, the latter shipping primarily to the U.S.A. Of the total volume of world trade in pyrites, flotation concentrates obtained through beneficiation of non-ferrous sulphide ores and washed pyrites, represented about 45%, virtually the same as in 1958. The high proportion is attributable primarily to exports from Cyprus, Yugoslavia and Canada. Exports from Canada are wholly, from Cyprus, predominantly, and from Norway partly in this form.

West Germany, France, Belgium and the Netherlands remained the largest importers of pyrites and between them received 66.5% of world pyrites exports. West Germany (36.7%) continues to dominate the market and in particular Duisburger Kupferhutte which in 1960 bought on behalf of its shareholders over 650,000 tons sulphur in pyrites, is the largest single purchaser of sulphur in the world, exceeding even the volume of brimstone purchases of the major U.S. acid makers or the bulk purchases of the National Sulphuric Acid Association in the United Kingdom.

Spain

Exports of 1.29 million tonnes in 1960 were 265,000 tonnes (25.8%) greater than in the preceding year and 119,000 tonnes (10.2%) greater than in 1958, but they were still

World Exports of Pyrites
('000 tonnes)

	1960	1959	1958	1955
Spain	1,291	1,026	1,161	1,539
Cyprus	1,081	979	1,065	907
Norway	466	408	395	473
Canada	347	296	408	460
Portugal	320	357	357	451
Yugoslavia	280	186	279	215
Italy	237	167	156	99
Finland	140	29	22	76
Cuba	77	27	36	77
Greece	51	36	80	119
Turkey	34	50	51	4
Sweden	29	36	69	16
Eire	9	—	—	—
Southern Rhodesia	—	2	38	4
Total	**4,362**	**3,599**	**4,117**	**4,440**

NOTE: The sums of individual data shown in statistical tables do not necessarily agree with totals shown as all figures are rounded off to the nearest thousand tonnes.

Spanish Pyrites Exports to W. Europe
('000 tonnes)

	1960	1959	1958	1955
West Germany ...	588	478	502	480
France	246	182	253	165
Belgium	178	122	94	253
Denmark ...	99	80	84	64
Netherlands ...	40	23	13	240
Eire	36	32	27	37
United Kingdom	32	34	49	192
Italy	11	9	46	58
Austria	—	22	13	—
Switzerland ...	—	3	4	1
Total	**1,230**	**985**	**1,085**	**1,490**

¼-million tonnes lower than in 1955 and over ½-million tonnes below the post-war peak of 1952. Of her exports only 6.6% were directed to destination outside Western Europe. Egypt received 47,437 tonnes under a bilateral agreement in part exchange for phosphate rock, Tunisia 1,572 tonnes, and 11,738 tonnes was shipped to Eastern Europe of which 9,818 tonnes went to Czechoslovakia and the balance to Yugoslavia. Over three-quarters of total exports are supplied by Cia Rio Tinto Ltda and the Tharsis Sulphur and Copper Company. These two companies and most of the lesser suppliers ship crude fines pyrites, some with an above average copper content. Exports of cupreous pyrites (over 1.5% Cu) in 1960 are estimated at about 40,000 tonnes, while exports of flotation concentrates are represented mainly by Minera Celdran of Carthagena, Cia Real Asturiana, and Rio Tinto "Confines."

By far the most important consumer of Spanish pyrites is Western Germany accounting for 46.9% of exports to European destinations. Shipments to Western Germany in 1960 of 588,082 tonnes were 18% greater than in 1959 — the first major expansion for about eight years and the highest post-war total.

The substantial increase of pyrites imports by Belgium in 1960 benefitted mainly the Spanish suppliers, and deliveries to this market were the highest since 1956.

Spanish pyrites exports to France were only 2.8% lower than in 1958, despite the 7.7% decrease in the level of exports to France from all sources, which was almost entirely due to lower shipments from Portugal. The French market is now the second largest outlet for Spanish pyrites and its size is largely determined by the French Government's desire to promote imports of products of Spain in order to avoid an excessive imbalance of trade.

Denmark increased her purchases by about 18% over 1958 and is now firmly established as the fourth largest user of Spanish pyrites.

Despite the modest improvement of shipments to Holland, exports of about 40,000 tonnes are but a fraction of this once important market for Spanish pyrites. This also applies to Italy and the U.K. where sales are, moreover, still declining.

Exports to Eire improved but 1960 will have been the last year in which exports to this market were significant as the principal consumer, W. H. and M. Goulding, has largely converted to brimstone use.

Neither Austria nor Switzerland renewed their purchases in 1960.

Cyprus

Exports of iron and cupreous pyrites from Cyprus reached a peak in 1960 and exports of 1.08 million tonnes were 1.4% greater than in 1958, and 19.2% greater than in 1959.

Cyprus Pyrites Exports
('000 tonnes)

	1960	1959	1958	1955
Netherlands ...	229	294	249	187
Italy	218	99	133	37
United Kingdom	207	155	149	196
France	184	169	187	176
West Germany ...	168	186	294	243
Belgium	76	77	54	19
Switzerland ...	—	—	—	10
Egypt	—	—	—	39
Total ...	**1,081**	**979**	**1,065**	**907**

Nearly three-quarters of total exports are provided by Cyprus Mines Corporation in the form of high grade concentrates and cupreous pyrites and the company's products are strongly represented in all markets for Cypriot pyrites. Hellenic Mining Company ships predominantly washed pyrites and some cupreous and the smallest supplier, the Cyprus Sulphur and Copper Company, almost exclusively cupreous pyrites, pending the start of flotation concentrates production this year. Exports from Cyprus of cupreous pyrites were as follows:—

	1960	1959	1958	1955
Cupreous pyrites ('000 tonnes) ...	253	312	232	141
% of total pyrites exports	23.7%	31.9%	21.8%	15.6%

The Netherlands remain the largest market for Cypriot pyrites and the decline of 8% compared with 1958 and 22% compared with 1959,

attributable to the conversions to brimstone use, will be more than made up when the CMC/Albatros pyrites acid plant at Peruis comes on stream this year.

Exports to France have been maintained at a high level, but those to West Germany are little more than one-half (57.2%) of those in 1958. Italy, favoured geographically, has become the second largest market for Cypriot pyrites, which have met the bulk of Italy's increased requirements.

The 33.7% increase in shipments to U.K. reflects both the greater demand for pyrites for acid manufacture in 1960 and the dominant position in this market which Cyprus Mines Corporation has established.

Belgium, the smallest market for Cypriot pyrites, remained virtually unchanged in 1960 at a level of 76,000 tonnes.

Portugal

Exports from Portugal declined in 1960 in contrast to the general trend. At 319,882 tonnes they were 10.4% lower than in the preceding year.

Exports are wholly met by Soc. Aljustrel and by Mines et Industries (Louzal) now that operations at the San Domingo Mine of Mason and Barry are declining due to depletion of available ores. Both exporting companies ship fines pyrites with above average copper content. Belgium, the domicile of the two companies, is understandably the main outlet for Portuguese pyrites and in 1960 this market represented a little under one-half of total exports.

Shipments to the Netherlands declined in 1960 as the effect of conversion to brimstone use made itself felt and in France changes in the supply pattern adversely affected Portuguese pyrites exports. The slight increase of shipments to West Germany failed to compensate for the loss of the small market in Eire, formerly supplied by Mason and Barry, and those in North Africa where Portugal had for many years supplemented indigenous supplies by shipments of about 7,000 tonnes to Tunisia and up to 1,500 tonnes each to Algeria and Morocco.

Portuguese Exports of Pyrites
('000 tonnes)

	1960	1959	1958	1955
Belgium	150	135	112	140
Netherlands	69	85	116	70
West Germany	68	61	64	71
France	32	63	50	101
North Africa	—	10	10	6
Eire	—	4	2	5
United Kingdom	—	—	4	5
Italy	—	—	—	4
Total	**320**	**357**	**357**	**451**

Norway

Exports from Norway — 466,144 tonnes in 1960 — have progressively increased in recent years and in 1960 were 14.2% greater than in 1959 and 18% greater than in 1958.

Norwegian Pyrites Exports
('000 tonnes)

	1960	1959	1958	1955
West Germany	282	217	155	161
Sweden	97	78	104	97
Denmark	50	56	46	77
East Germany	32	32	42	71
Czechoslovakia	5	14	21	14
France	—	2	11	23
Netherlands	—	9	10	24
Others	—	—	6	24
Total	**466**	**408**	**395**	**473**

The two principal exporters are Elektrokemisk A/B and Sulitjelma A/B now that the bulk of Orkla Grube's output is devoted to smelting operations. Other important suppliers to Norway's export markets are Bjorkaasen and Stordo, and several of the lesser mines also contribute. The bulk of exports consists of cupreous pyrites, notably from Elektrokemisk and Orkla, and of flotation concentrate or washed pyrites.

Norway's export trade in pyrites is determined by the requirements of West Germany and Sweden, although her traditional share of the Danish market and regular supplies to East Europe represent important outlets.

The increased level of exports is attributable primarily to the high level of shipments to West Germany which in 1960 represented 60.5% of total exports. Markets in Northwest Europe were lost in 1960.

Italy

Exports in 1960 totalled 236,649 tonnes an increase of 41.1% over 1959 and 51.4% more than in 1958. Italy is however a net importer of pyrites and changes in the level of exports result in correspondingly greater imports. Exports are represented wholly by Montecatini pyrites and the principal outlet is Soc. Montcatini's associate Cie. Neerlandaise del'Azote at Sluiskyl in the Netherlands.

Austria and Switzerland are also traditional markets.

Italian Exports of Pyrites
('000 tonnes)

	1960	1959	1958	1955
Netherlands	157	109	91	—
Switzerland	61	37	34	51
Portugal	—	—	—	6
Austria	18	19	31	36
Belgium	—	—	—	2
West Germany	—	—	—	4
Total	**237**	**166**	**156**	**99**

Canada

Exports in 1960 are estimated to have totalled 347,000 tonnes and although 27.3% greater than in 1959, they were about 15% lower than in 1958. This is attributable mainly to the decline of shipments to Western Europe, notably the U.K., and, to a lesser extent, the contraction of sales to U.S. which remain by far Canada's main export outlet.

Canadian Pyrites Exports
('000 tonnes)

	1960	1959	1958	1955
U.S.A.	315	270	341	363
West Germany	22	—	33	31
United Kingdom ...	10	27	34	67
Total	**347**	**297**	**408**	**461**

Exports are wholly in the form of flotation concentrates originating in the main from the mining operations of the Noranda Group of mines.

The resumption of production last year by Howe Sound Company at Britannia Beach, B.C. and the possibility of exports to Taiwan may provide a new export market for Canada.

Yugoslavia

Exports of 280,453 tonnes in 1960 correspond to the level achieved in 1958 and represented a 50.7% increase over 1959 results.

The bulk of Yugoslav exports are in the form of flotation concentrates resulting from the ore treatment of the lead/zinc ores of Trepca and the copper ores at Bor and Majdanpek.

The main outlet for Yugoslav pyrites is Western Europe, in particular Southern Germany which is readily accessible by the Danube. Italy, also favoured geographically, has established herself as Yugoslavia's second largest market.

Yugoslavia Pyrites Exports
('000 tonnes)

	1960*	1959	1958	1955
West Germany	130	56	65	36
Italy	80	36	42	30
Austria	4	6	7	11
Czechoslovakia	40	10	50	52
Switzerland	—	—	—	15
Hungary	2	4	29	21
Poland	20	58	51	35
Egypt	5	16	36	5
East Germany	—	—	—	10
Total	**280**	**186**	**279**	**215**

* Preliminary data

Others

Sweden. Mainly as the result of her loss of Eastern European markets (Czechoslovakia and Poland) the level of Swedish exports has declined. Wholly met by Bolidens Gruv A/B in the form of the high grade flotation concentrates, exports in 1960 totalled 29,380 tonnes, 22.9% less than in 1958. Shipments were directed primarily to U.K. (26,331 tonnes) and to West Germany (3,069 tonnes).

Finland. Exports in 1960 totalled 139,982 tonnes, a five-fold increase compared with 1959 and 1958. Wholly delivered to West Germany, Finland's exports are predominantly in the form of Outukumpu flotation concentrates, which on account of the high cobalt content of the residues are attractive.

Greece. In 1960 exports totalled 50,665 tonnes, an increase of 39.3% over 1959 but still 37% less than in 1958. Deliveries originate from the Kassandra Mine of the Hellenic Company for Chemical Products and Manures and in 1960 were directed to Austria (13,445 tonnes), Italy (12,020 tonnes) and Netherlands (20,460 tonnes). West Germany, Czechoslovakia and Poland were important customers.

Turkey. Exports — 33,580 tonnes in 1960 — are in the form of cupreous pyrites and are wholly directed to West Germany. In 1959 they totalled 49,600 tonnes and 51,357 tonnes in 1958.

Cuba. Of total Cuban exports in 1960 of 76,829 tonnes cupreous pyrites, 60,638 tonnes was shipped to West Germany and the balance to Belgium. In 1959 exports totalled only 26,576 tonnes and 36,081 tonnes in 1958.

Eire. Exports of 9,575 tonnes are wholly represented by deliveries of flotation concentrates from St. Patricks Copper Mines of Avoca. Exports are at present the only outlet for the large quantities of potentially marketable material.

MARKETS

Despite the substantial increase in the volume of pyrites exports in 1960 in response to increased demand, the share of pyrites in world trade continues to decline. Viewed only in terms of Europe, where pyrites traditionally are the principal sulphurous raw material for sulphuric acid and sulphite pulp manufacture, their share of trade in 1960 amounted to 57% of shipments of sulphur in all forms, whereas in 1958 pyrites accounted for 62% and 1955 for 68%.

Italy

Rising domestic requirements coupled with higher export commitments has caused a substantial increase in imports, which are being supplied primarily from Cyprus and also from Yugoslavia. The decision by Sincat at Priolo to base the second 300 tonnes a day sulphuric acid plant on imported pyrites and not on indigenous sulphur ores has resulted in a violent protest from Sicilian interests, but economics of operations in this and many other locations in Italy favour the use of pyrites particularly of those yielding attractive residues. The large-scale pyrites acid/residues project of Soc. Montecatini at Follonica is not expected to affect the absolute level of pyrites import requirements.

United Kingdom

The high rates of sulphuric acid production in 1960 favoured the full employment of pyrites roasting facilities and resulted in an appreciable increase in pyrites use which was not, however, fully reflected by the increase (4.5%) in pyrites shipments to the U.K. as Government and consumer stocks continued to be depleted. The preferred use of flotation concentrates in view of the existing, fairly modern roasting installations, accounts for the strong position established by Cyprus Mines Corporation and for the purchase of similar material supplies from Sweden.

West Germany

Although based on the year's export results of individual suppliers shipments to West Germany of 1.5 million tonnes pyrites were over 20% greater than in 1958 and 36% greater than in 1959. West German imports in 1960 were recorded at over 1.7 million tonnes mainly attributable to fortuitously heavy arrivals in January and in December 1960. Because of substantial reductions of consumer stocks in 1959 and subsequent building of stockpiles in 1960, neither year's level of imports is indicative of the level of consumption. The governing factors in West Germany's import pattern remain the suitability of residues in the light of the operational requirements of Duisburger Kupferhutte and the need for non-arsenical pyrites in fluidised-bed roasters. But for the latter the proportion of Spanish and Portuguese pyrites in West Germany's consumption pattern might be greater. Apart from strictly technical needs it is also evident that the purchasing policies of DKH are influenced by the desire to lend support to producers who, but for a market in West Germany, would have difficulty in maintaining production.

France

Contrary to earlier assumptions that large-scale availability of indigenous brimstone supplies would immediately cause pyrites use to be abandoned, the French pyrites market has proved stable. A combination of factors — in particular, existence of modern roasting

Shipments of Pyrites to Europe
('000 tonnes)

	Spain		Cyprus		Portugal		Norway		Others		Total	
	1960	1958	1960	1958	1960	1958	1960	1958	1960	1958	1960	1958
West Germany	588	501	168	294	68	64	282	155	391	229	**1,497**	**1,244**
Netherlands	40	13	229	249	69	116	—	10	178	110	**516**	**498**
Belgium	178	94	76	54	150	112	—	—	16	—	**421**	**259**
France	246	253	184	187	32	50	—	11	—	—	**462**	**502**
Italy	11	46	218	133	—	—	—	—	92	56	**320**	**235**
United Kingdom	32	49	206	149	—	4	—	—	44	34	**282**	**253**
Denmark	99	84	—	—	—	—	50	46	—	—	**149**	**130**
East Europe	12	6	—	—	—	—	37	63	62	196	**110**	**265**
Others	36	44	—	—	—	2	97	110	97	83	**230**	**236**
Total	**1,242**	**1,090**	**1,081**	**1,065**	**320**	**348**	**466**	**395**	**879**	**724**	**3,988**	**3,622**

installation notably at Kuhlmann works, competitive cost of sulphur in pyrites and Government trade policy notably vis-a-vis Spain and Portugal — point to the continued large scale use of imported pyrites, although their relative importance in the French consumption pattern is declining since new acid plants other than those at zinc smelters are exclusively being based on brimstone.

Belgium

In view of the competitive cost of sulphur in pyrites a large proportion of Belgium's increased sulphuric acid need in 1960 was met by the use of pyrites, reflected by the increase of pyrites shipments to this market of 25% compared with 1959 and 62% compared with 1958. Spain and Portugal benefitted most, while Cyprus maintained its level of shipments. The small imports of Cuban pyrites are made primarily in view of their residues value and Belgium's favourable situation in relation to Duisburg.

Netherlands

The decision in 1960 by ENCK to abandon the use of pyrites reduced the number of pyrites roasters to three. Of these, Albatros Superphosphaatfabriken, through its subsidiary jointly owned with Cyprus Mines Corporation, is on the point of increasing its annual requirements by about 100,000 tonnes of pyrites.

OUTLOOK

Whereas world brimstone trade in 1960 represented 40% of world consumption, world trade in pyrites of 4.36 million tonnes accounted for only 30.6% of world pyrites consumption (excluding U.S.S.R. and China). The increase of 243,000 tonnes in pyrite exports compared with 1958 represented about 38% of the increase in world pyrite production but, allowing for stock changes in importing countries, it is estimated, only about 20% of the increase in world pyrites consumption.

The prospects of increased pyrites export are centred in West European markets where at the same time competition from brimstone is the most severe. A number of European pyrites producers are able and willing to reduce their prices below to-day's level notwithstanding that pyrites at established roasting plants is already competitive with brimstone.

The favourable comparison is of course determined by the high value of pyrites residues, supplied either as direct blast furnace feed or as raw material for cinders treatment yielding high grade purple ore, non-ferrous and precious metals and salts, and the relatively low cost of sea freight at which pyrites can be moved.

In terms of operation costs the improved comparison with brimstone acid plants resulting from the use of fluidised bed roasters, and more recently hearth roasters with steam recovery, may be further enhanced when development work now in progress is successfully completed. At the symposium organised by Duisburger Kupferhutte held in September, some of the results were made known.

Impediment to Expansion

The main impediment to a major expansion of pyrites trade is the limitation of available roasting capacity and the higher cost of new plant which causes new plant investment to be made on the basis of brimstone. At current plant costs pyrites producers cannot expect to compensate for the difference by low prices alone and provision of capital to prospective builders of new plant in the form of participation or from special funds would seem the only way of overcoming this stifling disability.

Of the less tangible although nonetheless serious disadvantages of pyrites compared with brimstone, some — such as steam recovery or labour costs — have been resolved or can be reflected in the price of the product. The problem of contamination by pyrites or residues of other chemical processes at pyrites roasting plants is however a problem which should merit an intensive research effort on the part of the pyrites producers since its solution would remove a serious obstacle to increased pyrites use and trade.

In 1961 a modest increase in pyrites exports can be expected but it is unlikely that this trend can be maintained thereafter, mainly because new brimstone acid capacity coming on stream in West Europe will militate against the overfull employment of pyrites acid capacity.

Canada's Sulphur Production Increased 61.3% in 1960

Consumption in 1961 expected to be 1.1 m. s. tons

Pouring liquid sulphur into forms at British American Oil's Pincher Creek plant. The forms are made from pre-hardened sulphur and allow the liquid sulphur to cool, layer upon layer

ATTENTION of world sulphur industry is focused on Western Canada and in particular on Alberta, where the rapid expansion of the natural gas industry, which is based in part on wells yielding crude gas with varying contents of hydrogen sulphide, is simultaneously creating a new major source of recovered sulphur supply.

As yet the level of production is relatively modest, but the rate of new construction and investment in gas cleaning and sulphur recovery plants already indicates that by 1965 brimstone as by-product or co-product of clean gas and liquid petroleum gas will arise at an annual rate of 3 to 4 million tons which will make the Canadian West the second largest centre of brimstone production in the world.

Adverse Locations of Producers

In 1960 brimstone recovered from natural gas in Alberta, British Columbia and Saskatchewan totalled 451,800 short tons, representing 37.6% of total Canadian production of sulphur in all forms (1.2 million s. tons) which includes sulphur in smelter gas, in pyrite, pyrrhotite and in by-product ammonium sulphate from nickel refining and sulphur recovered in elemental form at oil and nickel refineries. Of Canada's total brimstone consumption in 1960, 500,000 s. tons—over two-thirds of the demand in the Eastern Provinces—was met by imports of Frasch sulphur. The new indigenous supplies meet the entire demand in the West and they are also being exported increasingly to the North-Western and Pacific states of the U.S.A., but their adverse location in relation to major markets is restricting the rate of deliveries and causing stocks to accumulate.

Recovered Sulphur

Nearly four-fifths of Canada's brimstone production in 1960 originated from Alberta, where the output of sulphur recovery plants amounted to 389,700 s. tons, an increase of 160,900 s. tons (61.3%) compared with that in 1959. The higher level of production is attributable primarily to the activities of Texas Gulf Sulphur Company, whose plant at Okotoks completed its first full year of operation, and British American Oil Company. The latter company was able to employ the expanded plant capacity at Pincher Creek—rated at 675 s. tons per day—and at Nevis the plant operated for the first full year. In Novem-

Sulphur Production
(short tons)

	Recovered Brimstone	Pyrite (Shipments)	Smelter Gas	Total†
1958	209,900	512,427	241,055	988,382
1959	327,500	418,220	278,204	1,048,924
1960	491,900	402,000	271,615	—
1961*	642,500	400,000	285,000	1,350,000

* Estimate.
† Including sulphur equivalent of by-product ammonium sulphate produced by Sherritt Gordon Mines Limited.

Brimstone Production
(short tons)

	1956	1957	1958	1959	1960	1961 (est.)
From natural gas						
Alberta	33,500	100,700	122,300	238,600	389,700	530,000
British Columbia	—	4,300	62,600	53,700	60,500	65,000
Saskatchewan	—	—	500	700	1,600	1,500
From oil refineries	—	—	22,000	32,000	35,100	36,000
From metal sulphides	3,000	2,400	2,500	2,500	5,000	10,000
Total	**36,500**	**107,400**	**209,900**	**327,500**	**491,900**	**642,500**

ber the company completed the 233 s. tons-a-day plant at Homeglen Rimbey but this did not come on stream until 1961.

The Innisfail gas processing and recovery plant of Canadian Oil Companies Limited* has been in production since November 1960. Production rate varies since a mixed gas is treated, and total sulphur production to the end of May amounted to 15,202 long tons.

Sulphur recovery at the Steelman, Sask., plant of Steelman Gas Limited has doubled, from 671 long tons in 1959 to 1,397 long tons in 1960. During the first quarter of this year Steelman Gas has averaged between five and six tons a day and it is expected that production will continue at this same rate throughout the year.

Recovery from Refineries

Laurentide Chemicals and Sulphur Limited, Montreal East, Quebec, in its second year of full operation, produced 31,400 s. tons, about 1,000 s. tons less than in 1959. The company's entire output is delivered in molten form—using 17-ton road tankers—to nearby consumers of whom approximately one-quarter are manufacturers of pulp; the balance goes to sulphuric acid manufacturers.

In New Brunswick, the new plant based on refinery gas at St. John is reported to have been completed in 1960. Built by Ralph M. Parsons of Los Angeles, it has a capacity of 30 s. tons a day. Production in 1960 is estimated at between 3,000 and 5,000 s. tons sulphur.

Pyrites

Shipments of pyrites in 1960 of 1,004,400 s. tons were 9.4% lower than in 1959.

Pyrites	1959	1960
Total pyrites (s. tons) ...	1,099,546	1,004,366
Sulphur content	440,000	402,000
$ value	3,433,095	2,828,267

Quebec remains the principal source of supply and the value of pyrites shipped in 1960 was Canadian $1.3 million which represents 40% of the total value of Canadian pyrites shipments. The value of production of pyrites in other Canadian provinces was as follows:—

	Canadian $	
	1959	1960
Ontario	632,140	556,230
British Columbia	950,432	973,665

In 1959 the value of Quebec pyrites shipments was Canadian $1.85 million, and the decrease is attributed primarily to the reduced level of activities in the uranium industry which in the Blind River Area is based on sulphuric acid produced from pyrites, and to lower exports. Noranda Mines Limited is the only supplier.

New Plants and Projects

Following the consent given in early 1960 by the various authorities to large-scale natural gas exports from Canada to the U.S., plant

Production in Alberta
(short tons)

Company	Location	1960	1959
British American Oil Co. Ltd.	Pincher Creek	175,269	134,753
	Homeglen Rimbey ...	4	—
British American Oil Co. Ltd. / California Standard Company	Nevis	36,526	1,487
Texas Gulf Sulphur Co. Ltd.	Okotoks	131,527	58,826
Shell Oil Co. of Canada	Jumping Pound	32,498	31,222
Royalite Oil Co. Ltd.	Turner Valley	9,136	10,398
Canadian Oil Cos. Ltd.	Innisfail	3,234	—
Imperial Oil Ltd.	Redwater	1,539	1,858
		389,733	**238,544**

* See Current Events

Plants Under Construction 1960-61 or on Stream 1961

Company	Location	Capacity Daily	Capacity Annual
British American Oil Co. (on stream 1961)	Homeglen Rimbey	233	81,500
Home Oil Company to operate on behalf of Carstairs Operators Committee (due on stream 1961 or 1962)	Carstairs	40	14,000
Jefferson Lake Petrochemicals of Canada Ltd. ...	Coleman, East Calgary ...	375	121,300
Petrogas Process Ltd.	East Calgary	863	312,000
Pan American Petroleum Co. Ltd. (on the basis of 330 days' operation a year)	West White Court	650	233,500

Plants Projected in Alberta

Company	Location	Capacity Daily	Capacity Annual
Shell Oil Company of Canada Ltd.	Pincher Creek	1,000 long tons	330,000
Canadian Superior Oil of California Ltd. ...	Didsbury		
Western Leaseholds Ltd.	Wildcat Hills, Alberta ...	75 long tons increasing to 120 long tons	26,300 to 32,000

construction started on several major projects and plans for additional new plants were announced. These include projects by individual major oil companies, notably Shell Oil of Canada, and also the Carstairs Operating Committee and Petrogas Process Limited, in which a number of lesser gas operators combine to operate one large-scale cleaning and sulphur recovery plant.

As indicated there are seven plants under construction during this year and in 1962 they will increase installed capacity by about 1,283,200 s. tons a year brimstone. When the present construction phase is completed there will be three major suppliers which will account for 51% of total capacity. Shell Oil of Canada (1,100 s. tons a day), British American Oil Company (978 s. tons a day) and Jefferson Lake Petrochemicals Limited (1,570 s. tons a day) not including this company's 330 s. tons a day plant at Taylor Flats, B.C.

Deliveries

Shipments of indigenous brimstone to domestic consumers and to export destinations

The new Innisfail crude stabilization gas - processing and sulphur recovery unit which came into operation November 1961. One lot of sulphur has been shipped and the second storage filling is now two-thirds joined

Rock sulphur at British American Oil's Pincher Creek gas-processing and sulphur plant being moved by loaders from the storage pipes to conveyor belts and then into railway trucks for shipment

—exclusively U.S.A. in 1960—totalled 310,000 s. tons compared with 174,970 s. tons in 1959. Domestic deliveries did not change significantly but exports increased from 26,526 s. tons in 1959 to 143,000 s. tons in 1960. The limiting factor on exports to the U.S. remained the high rail transport charges which appear to have restricted the radius of economic supply to about 800 miles, and preclude deliveries to the large Eastern Canadian market where the only indigenous brimstone supplies are those recovered from oil and nickel refineries.

Imports

Canada's brimstone imports in 1960 totalled 328,765 s. tons, a modest decline of 3,664 tons compared with the previous year. Supplies were met wholly by U.S. Frasch sulphur which was directed to consumers in Eastern Canada.

Consumption

In 1960 consumption of sulphur in all forms is estimated at 1.02 million s. tons sulphur, about 4% less than in 1959. Whereas use of sulphur in pyrites and smelter gases receded, brimstone consumption increased slightly and is estimated to have totalled 520,000 s. tons.

Pulp

The pulp industry remained the largest single brimstone user. In 1960 it is estimated to have consumed about 285,000 s. tons brimstone, and in addition some 75,000 s. tons sulphur in liquid SO_2 from smelter gases and in pyrites. Recession in viscose manufacture was reflected by an 11% reduction in dissolving pulp output but other sulphite pulp output rose substantially (9%), especially bleached pulp.

Sulphuric Acid Production

Production of sulphuric acid in 1960 totalled 1,652,900 s. tons, an increase of 43,300 s. tons (2.7%). Increased requirements in the manufacture of fertilizers as well as organic and inorganic chemicals helped to counteract the effect of reduced demand from the uranium industry which is estimated to have used only about 400,000 s. tons sulphuric acid.

Smelter Gas

In 1960 production of by-product sulphuric acid derived from SO_2 in non-ferrous metal smelter gases totalled 271,615 s. tons sulphur equivalent, 2.7% less that in 1959. The slight decrease was attributed to the subdued conditions in metal markets, notably in lead and zinc, throughout the year under review.

The by-product sulphuric acid plant of Sherbrooke Metallurgical Limited, Dunnville, Ontario, which uses SO_2 in zinc smelter gases to produce some 140,000 s. tons (100% H_2SO_4), came on stream in 1961. Sulphuric acid is shipped to Electric Reduction Company of Canada Limited at Port Maitland where it is used in the manufacture of phosphatic acid and phosphate fertilizers and industrial phosphates.

Border Chemical Company of Winnipeg has also completed its 50 s. tons-a-day contact sulphuric acid plant, but this operates on brimstone pending the completion of washing facilities for copper sulphides.

Outlook

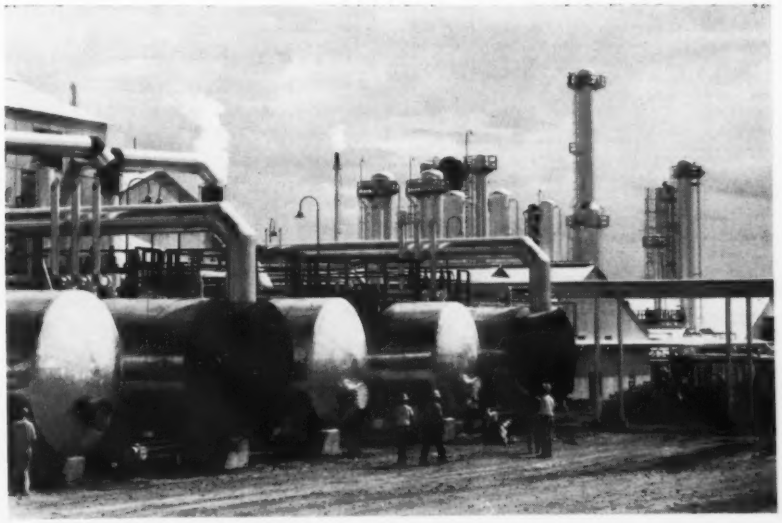
In 1961 domestic consumption in Canada promises to rise to 1.1 million s. tons sulphur. The pulp industry in the first four months

showed a 6% to 7% increase compared with the same period of 1960 and there is evidence of higher exports and growing demand for better papers. Major pulp and paper mills are producing in Eastern and Western Canada. The fertilizer and chemicals industries also anticipate that the increased level of activity in the first half will be maintained during the rest of the year.

Favourable domestic demand does not, however, significantly affect the supply pattern in Western Canada where production of recovered sulphur continued growing in the first half of 1961. In Alberta output rose to 240,700 s. tons, 18% more than in the first half of 1959, although in British Columbia it remained virtually unchanged at 31,000 s. tons.

Production of brimstone in 1961 is expected to total just under 650,000 s. tons but the difficulty of expanding sales rapidly can be expected to cause stocks to rise to over 600,000 s. tons. Canadian producers are probing potential export markets in the Far East and by the end of this year it can be expected that shipments to Taiwan, India, and possibly Australia, may reach an annual rate of 100,000 tons. Efforts to develop a market in China or Japan for Canadian sulphur continues. Under an agreement with the railway companies rates from Calgary to Vancouver were reduced 22% in the spring to $7.84 per long ton. Currently consideration is being given to a new rate from Calgary to Chicago at $12.88 per long ton but this is likely to be cancelled, especially before the U.S. Rail Tariff Commission.

The former reduction of rail rates for export sulphur is already favourably influencing the competitive ability of Canadian producers who now realize Can. $11 to $13 per ton *ex* works on exports. If the application on the rail rate to Chicago is granted Canadian sulphur will have access to one of the largest markets in the U.S.A. but competition from established suppliers will undoubtedly be much fiercer than Canada needs to expect in overseas export markets. The problem of finding markets at equitable prices for the rapidly mounting recovered sulphur output is far from being resolved and the suggestion is that a long term stock piling policy, designed to keep Canada's sulphur standing on the Prairies until the gap between world demand and production capacity is narrowed, is not thought to be sufficiently realistic to find favour either with the oil and gas companies or with Canada's sulphur producers. It can be expected that in 1962 they will make strong efforts to increase exports to 500,000 tons of which at least one-half will be directed to U.S. markets. As the bulk of production capacity is controlled by three or at most four major companies it can be expected that marketing policies will be designed to cause as little disturbance to the stability of world sulphur markets as possible.



A general view of the units at British American's Pincher Creek plant for processing natural gas for transmission and removal of propane, butane condensate and sulphur. The amine treaters for removal of H_2S and CO_2 are on the right

Japan's Sulphuric Acid Production Up 6·1% in 1960

ALMOST every sector of industry in Japan has consumed more sulphuric acid in 1960 than in 1959, with the notable exception of the nitrogenous fertilizer, metal and tar products industries. In consequence sulphuric acid production increased to 4.45 million tonnes (100% H_2SO_4)—6.1% more than in 1959. Plant capacity seems to have been strained, and indeed, it would seem that in order to meet sulphuric acid requirements, chamber plants due to be dismantled have continued in operation, and even those which have been out of action for some time would appear to have been brought into use again.

Raw Materials

In the year under review consumption of sulphurous raw materials increased by 6.2% and, continuing earlier trends, the use of sulphur in copper concentrates and zinc blende has increased by 15.6% and 12.7%. Use of iron pyrites rose to 4.6%. That of sulphur ores, including ore containing pyrites, has risen more steeply (+5.4%) for the first time since 1957.

Notable expansion in detergent industry

Plant Capacity

Whereas in 1959 and the first half of 1960 there was a trend towards faster expansion of contact sulphuric acid, in the second half of 1960 employment of chamber plants became very intensive. Nevertheless, this is only a temporary expedient and by 1962, when a substantial volume of new contact sulphuric acid capacity is due on stream, the former trend will re-assert itself.

More SO_2 from Smelters

Of the new plants, those of Toho Aen, Mitsubishi Metal & Smelting, and Furukawa Mining will be based on SO_2 in smelter exit gases. Plant capacity at various works is being increased by modifications of existing sulphuric acid installations. Sumitomo Chemical Company Limited has increased daily capacity from 925 to 957 tonnes (100% H_2SO_4) by the installation of waste-heat boilers. Operations at the company's Osaka works have been suspended and the seven plants at Niihama works have been modified.

(A) CONSUMPTION OF RAW MATERIALS

Tonnes

	1959	1960	% Change
Iron pyrites	1,968,658	2,059,457	+ 4.6
Pyrrhotite	230,044	237,807	+ 3.3
Sulphur ore including ore which contains iron pyrites	617,460	650,682	+ 5.4
Zinc blende	272,864	307,593	+12.7
Copper ore mainly concentrated including raw cupriferous ore	267,692	309,482	+15.6
Lead ore	22,152	22,190	+
Others	676	139	−85.0
TOTAL	**3,379,546**	**3,587,350**	**+ 6.2**

(B) PRODUCTION OF SULPHURIC ACID (as 100% H_2SO_4)

Tonnes

		1959	1960	% Change
ZINC BLENDE	contact	227,799	251,129	+10.2
	nitration	49,259	53,779	+ 9.1
	total	277,058	304,908	+10.0
COPPER ORE	contact	328,128	354,145	+ 7.9
	nitration	120,388	152,818	+25.2
	total	448,516	506,963	+13.1
PYRITES AND ORES	contact	2,276,044	2,371,892	+ 4.2
	nitration	1,193,790	1,267,791	+ 6.2
	total	3,469,834	3,639,683	+ 4.9
TOTAL	**contact**	**2,831,971**	**2,977,166**	**+ 5.1**
	nitration	**1,363,437**	**1,474,388**	**+ 8.1**
	total	**4,195,408**	**4,451,554**	**+ 6.1**

Sulphuric Acid Production July-December 1960
('000 tonnes)

	Pyrites and Ores	% Change	Copper Ores	% Change	Zinc Ores	% Change	Total	% Change
Chamber	634	+10.6	79	+15	27	—	**740**	+ 77
Contact	1,193	+ 3.6	179	+14	130	+10.1	**1,502**	+ 69
Total	**1,827**	**+ 6.0**	**258**	**+31**	**157**	**+ 8.3**	**2,242**	**+146**

CONSUMPTION

The fertilizer industry, the largest consumer of sulphuric acid in Japan, accounted for 61.6% of total acid use, compared with 66.7% in 1959. Requirements for the manufacture of nitrogenous fertilizers decreased 175,317 tons (10.2%) to 1,709,479 tonnes (100% H_2SO_4), reflecting the effect of rationalisation of synthetic ammonium sulphate manufacture, which, in view of the volume of by-product ammonium sulphate derived from caprolactam, now in excess of one-half million tonnes product, has been severely curtailed.

Fibres Second Largest Consumers

Second largest consumers of sulphuric acid are the man-made and synthetic fibres producers, whose demands increased 13.7% to 537,589 tonnes in 1960—also a new peak. Manufacture of chemicals, accounting for over 400,000 tonnes (100% H_2SO_4), and steel and oil refining are the next largest consumers.

Fastest growing outlets for sulphuric acid in Japan in 1960 were oils and fats (required in the manufacture of synthetic detergents), dyestuffs and intermediates, paper and pulp, activated clay, iron and steel and celluloid and nitrocellulose industries.

Expansion of Detergents

Detergent production is now expanding in Japan at a rate comparable with that in Europe in the mid-fifties. In the first half of 1961 it exceeded 91,500 tonnes, an increase of 44% compared with the previous year, and demand is such that all Japanese detergent manufacturers are increasing their plant capacities. It is estimated that demand in the second half of 1963 may reach an annual rate of 410,000 tonnes, some 8,800 more than the synthetic detergent demand forecast by MITI for 1965.

1965 Sulphuric Acid Estimates

Capacity will be increased to 300,000 tonnes a year, from the present 198,000 tons a year and by the second half of 1963 capacity will be 498,000 tons a year.

The Sulphuric Acid Association of Japan estimates that in 1965 consumption of sulphuric acid (100% H_2SO_4) will be 5.92 million tonnes to meet the demands primarily of the fertilizer, chemicals and synthetic fibre producers. Titanium dioxide, supplies of which were tight in 1960 and which in 1961, due to the strike at

Sulphuric Acid Consumption
Tonnes (100% H_2SO_4)

	1959	1960	Tonnes change	% change
Nitrogenous fertilizers	1,884,769	1,709,479	−175,317	−10.2
Phosphatic fertilizers	915,731	1,061,026	+145,295	+15.9
Man-made and synthetic fibres ...	472,827	537,589	+109,762	+13.7
Inorganic chemicals	256,933	336,625	+ 64,692	+31.1
Organic chemicals	74,037	96,055	+ 22,018	+29.7
Iron and steel	115,028	141,625	+ 26,597	+23.1
Petroleum	73,819	82,797	+ 8,978	+12.2
Dyestuffs and intermediates	46,963	66,302	+ 19,339	+41.1
Metal industry	32,042	29,797	− 2,245	− 7.0
Paper and pulp	28,505	38,702	+ 10,197	+35.7
Metallurgy	34,104	38,764	+ 4,660	+13.6
Oil and fat	21,005	32,363	+ 11,358	+54.0
Celluloid and nitrocellulose	14,652	17,756	+ 3,104	+21.2
Activated clay	18,652	23,447	+ 4,795	+25.7
Tar products	12,635	10,243	− 2,392	−18.9
Others	199,340	218,668	+ 19,325	+ 9.7
Potassium fertilizers	—	17,557	+ 17,557	—
Total	**4,201,042**	**4,458,795**	**+257,754**	**+ 6.1**

Japanese Synthetic Detergent Producers

Company	Site	Monthly capacity tonnes	On stream
Koa Soap Company	Kaivasaki	3,000 granular	March 1962
		1,500 liquid	
Daiichi Kogyo Seryaku Company ...	Yokohama	1,000	1963
Lion Fat & Oil Company	Nada	1,500	1962
Miyoshi Oil & Fat Company	Kyushu	3,000	1963
	Tokyo	1,500 liquid	
Asahi Electrochemical Company ...	Tokyo	1,500 additional	1963
Nippon Oils & Nagoya Fats Company	Nagoya	3,000	Second half 1962
Maramija Company	Takasaki	3,000	January 1962
Kanegafuchi Chemical Company ...	Takasaki	1,500	1962
Shiseido Company	Tokyo	1,500	1962
Others		1,500	1963

Ishihara Sangyokk were further restricted, is entering an expansion phase in Japan, and in 1962 and, particularly in 1963, the industry is expected to make heavy demands on sulphuric acid supplies.

Outlook

Representing an annual growth rate of 5%, the increased production of sulphuric acid will entail a correspondingly greater supply of raw materials estimated at about 430,000 tonnes sulphur content. It is expected that volume by-product smelter acid will continue increasing, and whereas current output is about 850,000 tonnes (100% H_2SO_4), of which over two-fifths originates at copper smelters, by 1963 this should exceed 1.1 million tonnes. The leading Japanese non-ferrous smelters—Nippon Mining Company, Mitsubishi Metal Mining, Sumitomo and others are making great efforts to expand sources of copper concentrates and are entering into contracts in Australia, Philippines, South America, and also in Canada, where recently Craigmont Mines of Merritt undertook deliveries of copper concentrates with a copper content of 30% and a sulphur content of 30%.

As yet 80% of the sulphur requirements of the acid industry are met by iron pyrites and sulphur ores, and brimstone does not play any part in the raw materials supply pattern, although one producer is reported to have started recently small-scale manufacture of brimstone acid. The mining companies appear to be capable of meeting the increased requirements of pyrites, etc., but if brimstone imports were liberalised by the Government, which is at present under consideration, it could well result in increasing use of brimstone in this sector of industry.

New Sulphuric Acid Plants Planned

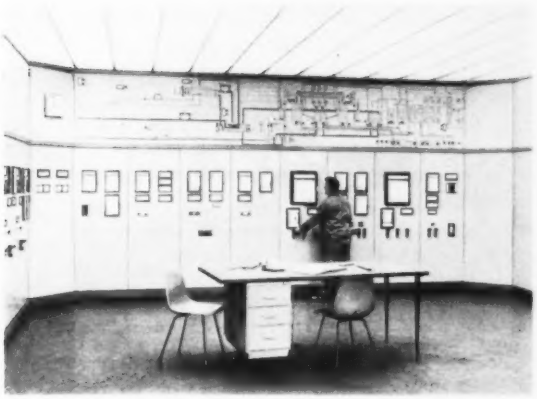
Company	Site	Capacity	Type	On stream
Dowa Mining Company	Yawata	600 tonnes/day	Monsanto	1962
Ishihara Sangyo K.K.	Osaka	200 tonnes/day	Chemiebau	1961
Nihon Kokan K.K.	—	400 tonnes/day	Lurgi	March 1962
Furukawa Mining Company	Ashio	210 tonnes/day	Monsanto	Sept. 1961
Mitsubishi Metal & Smelting Company	Onahama	20 tonnes/day	—	1963-1965
Toho Aen Company	Onahama	6,000 tonnes/year	—	1965

Sulphuric Acid Demand Estimates
'000 tonnes 100% H_2SO_4

Industry	1960 Consumption	1961 Demand estimate	1965 Demand estimate
Fertilizer	2,770.5	3,035.2	3,126.0
Chemical and Synthetic Fibre	537.6	578.1	639.5
Others	1,150.7	1,357.8	2,153.9
Total	**4,458.8**	**4,971.1**	**5,919.4**
Re-used spent acid	88.7	120.8	169.6
Necessary production	4,370.1	4,821.3	5,749.8

Multi-hearth Steam Generation Furnaces for Pyrites

In operation at Farbenfabriken Bayer AG.



Control room of Bayer's multi-hearth furnace plant

AT THE technical meeting held at Duisburg on 21-22 September, under the auspices of Duisburger Kupferhutte to discuss relevant and topical aspects of pyrites residues, Dr. F. Stauf, of Farbenfabriken Bayer AG., reported on his company's experience with multi-hearth steam generation pyrite furnaces.

Earlier furnace developments centred primarily on greater mechanisation and increased throughput and it was not until the 1950's that the development of fluidised bed furnaces, notably by B.A.S.F., enabled pyrites roasting to be combined with the recovery of steam on a large industrial scale. Fluidisation did, however, cause disintegration of residue grains due to the force of reaction, and in the case of pyrites containing arsenic and lead difficulties arise in removing these troublesome impurities from the residues. Neither disability had been experienced in multi-hearth furnaces and once the technical aspects of embodying in this type of furnace facilities for steam recovery had been resolved, Farbenfabriken Bayer decided to instal it.

150 Tonnes-a-day Unit

In May 1960, a unit, designed to produce 150 tonnes of SO_3 per day was put into operation. It comprised :—

(a) A roasting plant, consisting of two multi-hearth furnaces.

(b) A steam generating plant with three waste-heat boilers, working on a closed steam cycle.

(c) A roaster gas purification plant, consisting of two hot chambers connected in parallel for electrostatic purification, two washing towers, six wet chambers for electrostatic purification and three driers.

(d) A blower installation, a contact system and absorption equipment.

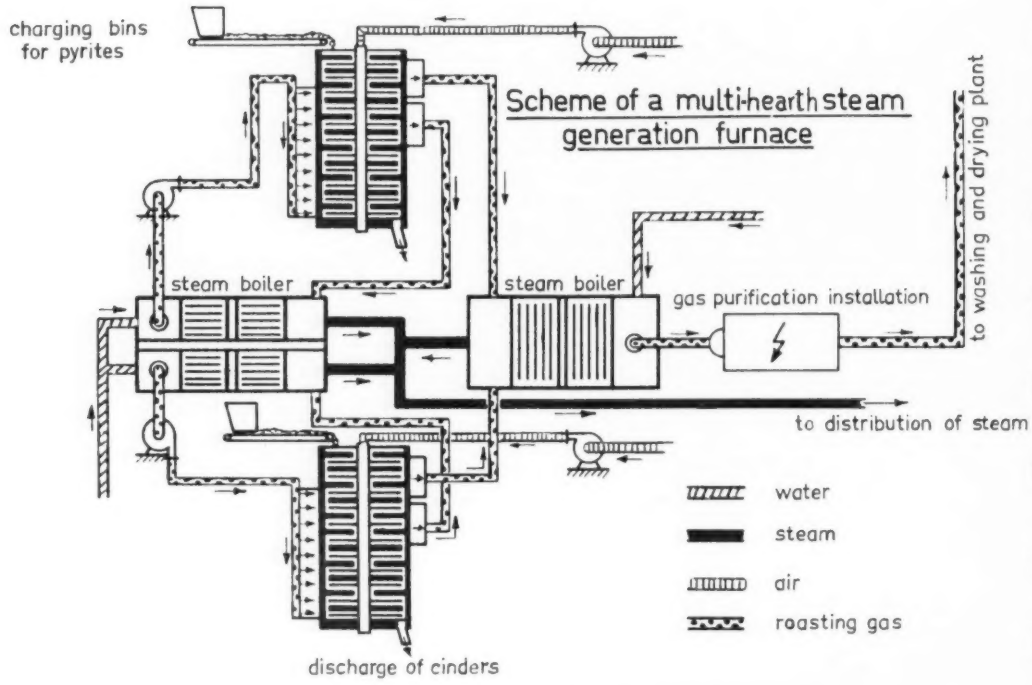
Essentially, the new features are the roasting and steam generation plants.

Klöckner Humboldt Deutz AG. of Köln assisted in the construction of the new plant by supplying the multi-hearth furnace; the steam generating plant was supplied by Oschatz GmbH. Each of the multi-hearth furnaces has an associated boiler through which the roaster gases from the intermediate hearths are cooled and recirculated to the furnaces. The third boiler, which takes the roaster gases from both furnaces, is used for generating steam. A heat exchanger incorporated in the plant reduces the pressure of the steam from the waste heat boilers from 90 to 30 atmospheres.

Division of the steam plant into two recirculating and one generating boiler was effected to prevent an increase in the arsenic content of the pyrites cinders.

Roasting Plant

Pyrites—arsenical fines of conventional quality—is carried from surface storage by elevators to charge bins whence it is conveyed on a variable dosage conveyor belt to the drying hearth of the furnace. It is then fed into the furnace by four rabble arms. The furnaces have one drying hearth and 11 roasting hearths, of which the first 10 are each equipped with



two rabble arms and the eleventh hearth has four rabble arms.

Roasting Furnace Data

Outside diameters	700 cm.
Inside diameter	620 cm.
Height	1,050 cm.
Number of hearths (drying)	1
" " " (roasting) ...	11
Roasting area, including area of pyrites feed	318 m²
Roasting area, less area of entrances	280 m²

Each furnace has a blower for cooling air which is forced through the central shaft and the rabble arms of the first eight hearths. This is subsequently passed into the roasting chamber as hot combustion air through the blast arms of the ninth, tenth and eleventh hearths. Air valves fitted to each hearth allow more air to be drawn into the furnace if necessary. Pyrites cinders are discharged from the lowest hearth into a water-cooled Redler conveyor carrying cinders to storage.

Roaster Gases

Roaster gas can be withdrawn from the first, second and third hearths of each furnace and after passing through separate walled ducts they are united into one stream to enter the generating boiler after passing through bundles of steam pipes mounted at the roof of the boiler and across the direction of gas flow. The gases leave by way of two gas pipes. Dust from the cinders, carried along by the gas and partially deposited in the boiler, drops into small hoppers suspended at the bottom and is discharged to another Redler dust conveyor. Dust deposited on the tubes decreases the rate of heat transfer, it is removed by automatic shakers and hand-operated hammers.

From the generating boiler cooled roaster gases are fed into two hot chambers connected in parallel for electrostatic purification. Residual dust in the gas is precipitated and the gases are then passed for further purification and cooling to a washing plant comprising two towers. Subsequently the gas is passed through six wet chambers connected in three parallel pairs of further electrostatic precipitation. Before entering the dryers, air is introduced to dilute the roaster gases, so that SO_2 concentration is reduced from about 13% to approximately 7%.

If for any reason the waste heat boiler is to be eliminated from the circuit the roaster gases can be drawn direct from each furnace to the washing plant, by-passing the generating boiler and the hot chambers. The furnace charge must, however, be reduced by 50% to avoid (1) overheating and hence sintering of the pyrites; (2) damage to lining of the washing towers by overheated roaster gases. Circulating roaster gas, which carries off a great part of the roasting heat and decreases the maximum hearth temperature, can be drawn off from the fourth, fifth and sixth hearths of each furnace through individual apertures by way of a roaster gas collector. It is fed into the associated boiler and cooled and it is returned to the respective furnace through a blower.

Steam Generation Plant

This plant consists of a La Mont system operating at 90-95 atmospheres and a conversion plant to reduce the pressure to 30 atmospheres. The high steam pressure of the La Mont system was selected to maintain the corresponding steam temperature in the waste-heat boiler of 300°C, at which there is no significant condensation of arsenic and lead compounds on the steam coils. As_2O_3 condensation occurred only below 280°C.

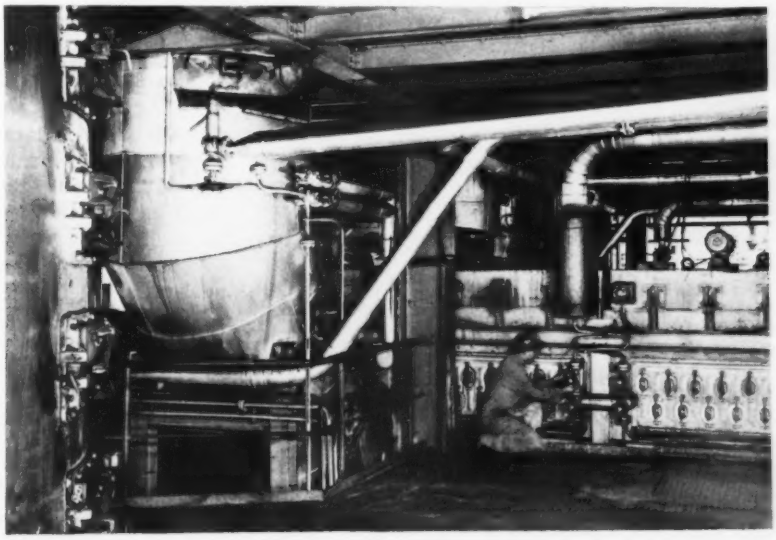
Plant Operation

The plant was designed to produce 150 tonnes of SO_3 per day, but after initial difficulties were overcome output was increased to an 190 tonnes of SO_3 per day. Rio Tinto and Tharsis pyrites, with a maximum grain size of 6mm. and average composition of 48% S, 0.43% As, 0.032% Sb and 0.6% Pb are charged at a daily average rate of 85 to 87 tonnes per furnace. Through the central shaft and the rabble arms of the ninth, tenth and eleventh hearths 5,500-6,000 s.c.m. of air per hour is blown into the furnace. The remaining air required for roasting—about 3,500 s.c.m. per hour—is drawn through air valves and door flaps, mainly at the tenth and eleventh hearths. The amount of air drawn in is such that the roasting gas contains about 13% SO_2 on leaving the furnace. Specific roasting capacity is 303 kg. of pyrites per m^2 per day.

The high degree of roasting can result in the S content of pyrites cinders being down to 1.25%. Composition of the cinders is reported by Dr. Stauf as: 0.12% Pb, 1.3% S, 0.012% As, 0.004% Sb.

Advantages of the New Furnaces

These new furnaces developed by Bayer with an average roasting capacity of 5.34 kg. of sulphur per m^2 of roasting area (including holes) per hour have proved to be superior to the older-type furnaces, the roasting capacity of which is only 3.6 kg. The new furnaces also produce a pyrites cinder of considerably better



Part of the La Mont steam generation plant

The drying hearth

quality with regard to the degree of roasting and the content of foreign metal impurities.

Dust precipitated amounts to about 8 tonnes a day or about 6% to 7% of the pyrites cinders discharged. Some 2% to 3% is precipitated in the waste-heat boilers and about 4% in the hot chambers. Steam recovery to date is 1.15 tonnes per ton of pyrites but can be increased. In the light of operating experience, Dr. Stauf concluded, the problem of roasting arsenical pyrites in multi-hearth furnaces with steam recovery can be considered as solved.

Investment

It is estimated that capital investment on the steam plant is DM 1½ million and DM 4½ million for the two multi-hearth furnaces. Amortisation of the steam plant is expected to be achieved in three to four years. Full operating experience is expected to lead to plant design necessitating lower investment and it is also foreseen to lower operating costs which at present are 10% to 15% greater than those of a fluidised bed furnace of similar capacity.

Farbenfabriken Bayer has also modified six small (30 tonnes a day pyrites) multi-hearth roasters and linked their roaster gases into one boiler system. As yet neither capital nor operating costs are available, but if successful this development would prompt modification, and thereby economic operation, of many existing pyrites roasting plants.

Metallic Oxides for Removal of Low SO_2 Concentrations

INVESTIGATIONS into the use of solids for removing sulphur dioxide in concentrations of less than 0.5% from combustion and waste gases are being conducted by the U.S. Bureau of Mines in co-operation with the U.S. Public Health Service in connection with air-pollution studies. Bienstock *et al* of the U.S. Bureau of Mines have reported results of extensive investigation using metallic oxides as absorbents, adsorbents and oxidation catalysts at 130° to 330°C (temperatures at which flue gas may be treated in power plant practice)

The most active absorbents tested were oxides of manganese, cobalt, copper and alkalized alumina; 23 to 33 grammes of SO_2 were removed by 100 grammes of absorbent at 130°C, while scrubbing more than 90% of the SO_2 from a simulated flue gas, and 19 to 61 grammes of SO_2 were removed at 330°C.

In a more detailed study on absorption and regeneration, using manganese oxides and alkalized alumina, adsorption of SO_2 on activated carbons and molecular sieves at elevated temperatures is reported to be considerably less efficient than removal by adsorption—a maximum of 7to 8 grammes of SO_2 could be removed with 100 grammes of adsorbent at 13°C.

A potash promoted vanadium pentoxide catalyst is stated to be effective in converting SO_2 to the trioxide; complete conversion in a simulated flue gas containing 0.35% SO_2 was obtained at 365°C.

Pilot-plant and cost studies are now being made by the Bureau of Mines to determine the economic feasibility of removing on an industrial scale the SO_2 present in gases in low concentrations.

Pyrites in Europe Hold Sulphur Price Balance

Prospects marred by lack of new roasting plants

DURING the past year the competitive position of pyrites has improved consistently in practically all European markets and the major producers in Spain, Portugal, Cyprus and Norway are in the position where their decisions in respect of 1962 pyrites prices will have a greater influence on the general level of sulphur prices in Europe than they were able to exert for nearly 10 years. At present the cost of sulphur in pyrites to most European consumers is, thanks to favourable residues values and freight costs, approximately one-half that of brimstone and the price basis which is provided by Spanish pyrites—in particular Rio Tinto and Tharsis at 60s. and 61s. per tonne of crude fines pyrites basis 48% sulphur f.o.b. Huelva—has been stable for two years although pressure by some producers to secure by price reduction a larger share of the total sulphur market has been evident.

The exceptional expansion of European brimstone demand in 1960 encouraged the major producers in U.S.A., Mexico and France to raise prices for 1961 contracts and especially Sulexco repeatedly affirmed their intention to enhance the participating producers' net return from the export sales. Efforts to do so in July of this year failed but the intention remains to secure for 1962 at least $1 to $1.50 over 1961 price levels.

Higher Brimstone Prices in Overseas Markets

In the major markets outside Europe and especially those where expanding demand offers increased outlets for all competing brimstone suppliers, it can be expected that delivered prices and corresponding returns to producers on an f.o.b. basis will increase by such a margin. The realisation of this objective in the major European markets, which account for about 55% of world trade of sulphur in all forms, is less assured. The substantial increase to 1.4 million tonnes of recovered sulphur output from French natural gas at Lacq and the individually negligible increases at oil refineries throughout Europe, which in aggregate, however, may total as much as 20,000 tonnes brimstone, emphasise the excess of sulphur supply over anticipated demand which is accentuated by the expectation of trial shipments of Canadian recovered sulphur and the increased pressure of offers of Russian and Polish sulphur. Despite the inroads which these supplies from Communist countries have already made in Western Europe at prices up to $4 per tonne below those of U.S., Mexican and French suppliers, the latter are unlikely to be influenced by this competition in their assessment of 1962 prices.

The determining factor is expected to be the level of pyrites prices. If higher brimstone prices were to increase the cost differential in favour of pyrites, some of the major consumers in Western Europe, in particular Belgium, and possibly also U.K., can be expected to increase their consumption of pyrites in preference to brimstone. Moreover, it would give consumers lacking flexibility in their use of raw materials a stronger incentive to meet a part of their brimstone needs by purchasing more Polish and Russian sulphur, the lower cost of which would reduce their overall sulphur costs.

Pyrites Demand and Residues Disposal

Following the strong recovery of pyrites trade in 1960 which raised exports by European producers to 3.9 million tonnes pyrites, the level of shipments has been substantially maintained in 1961. The principal contributing factor is the profitable disposal of pyrites residues and in this respect the activities and policy of Duisburger Kupferhütte, the world's largest pyrites residues treatment plant, have a decisive influence on the stability of the pyrites market and the prosperity of the pyrites industry. In 1961 DKH will treat approximately 2.0 million tonnes residues

representing about 3 million tonnes pyrites and about 68% of total European pyrites imports.

Technical Meeting at Duisburg

Attended by the representatives of most European pyrites producers and the principal consumers, the technical meeting held at Duisburg on the 21-22 September provided a platform for the review of various aspects of cinders treatment.

Residues treatment problems and current operations at Duisburger Kupferhütte were reviewed by Dr. O. Emert and Dr. B. Thier respectively and Dr. F. Stauf of Farbenfabriken Bayer AG. presented the operating results of multi-hearth pyrites furnaces with steam recovery at Leverkusen (see page 15).

The substantial improvement in the economics of pyrites roasting which have resulted from the close co-operation between producer, roaster and residues processer are reflected in the trade results of recent years, and the prospects of competitive production costs of SO_2 based on pyrites are favourable, especially as it appears to be the policy of DKH to ensure this.

Absence of New Pyrites Roasting Capacity

As yet unresolved is the problem of the disproportionately high capital cost of pyrites acid plants compared with those based on brimstone, which is reflected by the fact that apart from two new plants in which pyrites producers have assumed part or all the responsibility for the provision of capital, no new pyrites acid plants are at present being built or projected in the major pyrites importing countries of Western Europe to-day. Although the differential between the capital cost of acid plants based on pyrites and brimstone—which can be said to range from 1.5 to 2.5 times—is often exaggerated, it is nevertheless a real deterrent both to the established manufacturer faced with need to re-equip or expand his pyrites installation and to the new producer planning an installation from "grass roots."

In Western European countries the majority of pyrites roasters still have a margin of spare capacity, sufficient to enable them to increase their consumption by about 10 to 15% if the favourable cost of sulphur in pyrites should warrant. The pyrites producers efforts to secure a larger share of the growing European demand for sulphur in all forms would therefore seem to be determined not so much by further short-term improvements in the relative cost of sulphur but primarily by their ability to resolve in the long term the problem of the heavy capital burden for new pyrites-based plant which sulphuric acid manufacturers are unable or unwilling to shoulder.

PRICES

Frasch Sulphur

U.S.A. Prices posted by U.S. Frasch sulphur producers remain unchanged at $25 per ton f.a.s. U.S. Gulf ports for bright sulphur, with discounts of $1 per ton for off-colour sulphur and $1.50 per ton for delivery for *ex* mine. The posted prices remain notional with the exception of a small number of protected markets but freight contributions and other discounts have declined in respect of increasing volume of sales for which prices were raised last July.

Competition remains strong especially for new business, the bulk of which is centred in the Tampa, Florida, area where new sulphuric acid/fertilizer plants are being brought on stream. Here and at other molten sulphur terminals of the three main suppliers to the U.S. domestic market—Texas Gulf, Freeport, Pan American Sulphur Company—sales and prices tend to be based on these new distribution points. Greater economy of liquid bulk transport appears to result in a slight improvement of producers' net returns. Current prices in the Tampa area and along the Gulf of Mexico range from $24.50 for dark sulphur, delivered in liquid form, to $26 for bright sulphur. In the up-river area along the Mississippi prices range from $25 to $27 and in the North Central States and Great Lakes area, which receives the bulk of supplies by way of transfer points on the Mississippi, and to a small extent by way of the St. Lawrence seaway, $26 to $27.50. A decision is at present pending with regard to the application by Canadian sulphur producers for a rail rate from Calgary to Chicago at $12.88 per long ton which if approved could result in severe price competition in this area between U.S. Frasch sulphur and Canadian

recovered sulphur. Prices along the Atlantic Seaboard are around $26.50.

Mexico. Posted prices for shipment to U.S.A. and other export destinations remain at $23.50 for bright sulphur and $22.50 for off-colour material. Effective returns to producers are reported to be higher than last year although the low prices in the Tampa area due to severe competition are an adverse factor.

Export Prices

In Western and Northern Europe delivered prices of U.S. and Mexican Frasch sulphur and of French recovered sulphur have remained in the range of $26.50 to $31 per tonne c. & f. The continued offers of Russian and, also more recently, of Polish sulphur at up to $4 below the landed prices of established suppliers, have not affected the general price level. Some 75,000 tonnes of Russian sulphur are expected to be delivered in 1961 to Scandinavian and West European consumers. In India delivered prices for U.S. and Mexican sulphur and of French recovered sulphur range from $31 to $34 per tonne c. & f. In South America the U.S. Frasch sulphur is delivered at $32 to $33 per ton. Offers of Canadian sulphur in South-East Asia and the Far East are reported at up to $4 below established price levels although no new sales are reported.

Recovered Sulphur

Prices of indigenous recovered sulphur in domestic markets have remained stable. In Western Germany brimstone recovered at oil refineries and by Ruhr Gas AG. ranges from DM 118 to DM 120 at Hamburg and DM 118 to DM 125 per tonne *ex* works in the Ruhr. In Sweden brimstone recovered by Svenska Skifferolje A.B. is sold at Skr. 158 to 160, a part of the output being delivered in the form of fine granules.* In Holland recovered sulphur is sold at Dfl. 99 to 104 and in Belgium at around B.Frs. 1,300 per tonne delivered.

Pyrites

In the second half of 1961 prices of European pyrites are substantially unchanged. Rio Tinto crude fines are priced at 60s. basis 48% sulphur f.o.b. Huelva, and Tharsis crude fines pyrites at 61s. Other Spanish pyrites are priced correspondingly within their narrow limits except for a small number of small Spanish producers of low grade pyrites whose prices are up to 12s. per tonne lower and Rio Tinto confines 10s. lower. Portuguese pyrites are based on 58s. per tonne f.o.b. Setubal basis 48% sulphur and Cypriot and Norwegian pyrites are priced competitively. Average export value of Cypriot iron pyrites during the period January to July 1961 was 59s. 6d. per ton. Russian pyrites continue to be offered at prices ranging from 62s. to 68s. per tonne c. & f. U.K. or Western Europe and in addition to a major sale to Italy, a shipment of a trial cargo of Russian crude fine pyrites to France is reported.

SUPPLY

World production† of sulphur in 1961 is expected to total 18.7 million tonnes, an increase of about 4%. The main expansion is foreseen in the output of recovered brimstone which is expected to be 450,000 tonnes greater than in 1960 mainly as a result of French and Canadian natural gas operations. Consumption in 1961 has advanced more slowly and it is expected that world stocks of brimstone will increase by about 300,000 tonnes.

U.S.A.

In response to growing domestic consumption Frasch sulphur output rose in the third quarter and monthly output averaged about 470,000 tons. The level of Frasch sulphur stocks of about 3.9 million tons is about 200,000 tons greater than one year ago.

Mexico

The current level of Frasch sulphur production increased to about 110,000 tons per month, some 25,000 tons more than in the early summer, but 4% less than in the autumn of 1960. Following the start of regular production by Central Minera S.A. which currently produces 5,000 to 6,000 tons monthly, there are now three producers but exports are still represented only by Pan American Sulphur and Gulf Sulphur companies. In July over 130,000 tons was shipped abroad raising total exports up to July 1961 to 680,000 tons.

* Not in liquid form as previously reported.

† Excluding U.S.S.R. and other Communist countries

Poland

Production at the Machow refining plant is reported to be maintained at a level of about 11,000 tonnes monthly and the production target of 114,000 tonnes in 1961 is expected to be reached without difficulty. Exports of 30,000 tonnes to Czechoslovakia and 20,000 tonnes to Western Europe and Baltic states are foreseen this year. Deliveries have been made to Sweden, Austria and Western Germany.

China

Under an agreement with Brazil covering reciprocal trade to the value of £10 million China will export sulphur.

Italy

During the four months ended June 1961 deliveries of brimstone totalled 52,633 tonnes of which 21,035 tonnes was exported. Production in this period amounted to only 23,163 tonnes and the balance of deliveries was made from stock. At the end of June stocks at EZI warehouses amounted to 124,039 tonnes, a 30% reduction compared with June 1960.

Taiwan

Production in 1960 of sulphur refined from native ores and recovered at the China Petroleum Corporation's oil refinery totalled 4,874 tonnes, about one-half the output in 1957. High production costs of native ore have caused four of the eight refined sulphur producers to suspend operations.

RECOVERED SULPHUR

U.S.A.

Recovered sulphur output is being maintained at a level in excess of 70,000 tons per month and this increased level of supplies is readily absorbed by the market.

France

Output of recovered sulphur by SNPA at Lacq is being raised to full plant capacity of 4,000 tonnes per day. In July when sulphur output totalled 86,988 tonnes and also in August and part of September maintenance work on gas cleaning and sulphur recovery units as well as at gas wells kept output at about 75% of capacity. Deliveries are being maintained at a level of about 80,000 tonnes monthly of which about 30,000 tonnes are directed to the home market. During the first seven months of this year stocks at the plant and at the port of Bayonne increased about 80,000 tonnes.

PYRITES

West Germany

Plant modernisation and extension of the ore flotation installations at Meggen are reported to be making satisfactory progress and when completed by the end of 1962 about three-quarters of the increased output will be in the form of concentrates containing 47 to 47.5% S.

Cyprus

Shipments of Cypriot pyrites during the period January to July are reported to have totalled 547,213 tons including 82,446 tons cupreous pyrites. This represents a decline of about 120,000 tons compared with shipments during the first seven months of 1960 attributable to lower deliveries by Hellenic Mining and Cyprus Sulphur and Copper Companies and to reduced shipments and production of cupreous ore by Cyprus Mines Corporation, the result of the introduction by the Government of a five-day week. Cyprus Mines Corporation shipments of pyrites concentrates are reported to be virtually the same as in 1960. New ore reserves are reported to have been discovered at Ayios Joamis in the Pitsilla district. The deposit is described as cupreous pyrite with high copper content.

Bulgaria

At the Srdna Gora Copper Combine in Central Bulgaria ore treatment at an annual rate of four million tonnes is due to start in 1963 and is to yield among other products 140,000 tonnes pyrites concentrates. Plans provide for capacity to be doubled by 1966.

N. Rhodesia

Under consideration is the possibility of reopening the King Edward Mine near Lusaka as a source of pyrite for use in copper smelting operations.

PLANT DEVELOPMENT

U.S.A.

Swift and Company has commissioned Leonard Construction Company to engineer and build a sulphuric acid plant to meet the company's needs for increased fertilizer production of ammonium phosphates. Due for completion in April 1962 the new plant will treble the company's acid output. It will be sited at Bartow, where Swift has two other plants.

Mexico

Cia. Metalurgica de Penoles which acquired a 51% interest in the former subsidiary of American Metal Climax plans to build a by-product sulphuric acid plant in conjunction with a zinc refinery at Torreon, Coahuila. Acid output is expected to be 40,000 to 50,000 tonnes a year (100% H_2SO_4). The company also plans a sodium sulphate plant which at a cost of U.S. $2.3 million is to be brought on stream this year.

Rumania

At Navodari a second pyrites acid plant has been brought on stream which has a design capacity to be reached by the end of this year, of 150,000 tonnes a year (100% H_2SO_4). In 1959 Rumania produced 199,000 tonnes sulphuric acid.

Iraq

A rayon plant with an annual capacity of 8,000 tonnes is projected at Sadat al Hindaya as part of a petrochemical combine.

India

The project to recover sulphur from Amjor pyrites is to be combined with a major sulphuric acid plant. After liberation of sulphur for recovery as element the balance of the pyrite sulphur is to be roasted to SO_2 and sulphuric acid production at 1,000 tonnes (100% H_2SO_4) is reported to be envisaged.

Poland

The Wizow plant which is currently Poland's main producer of sulphuric acid, and is based on the use of gypsum, is to be reconstructed to the use of brimstone. Reconstruction to be carried out under the country's sulphuric acid production programme and the plant's expansion to large-scale inorganic chemicals manufacture will begin next year.

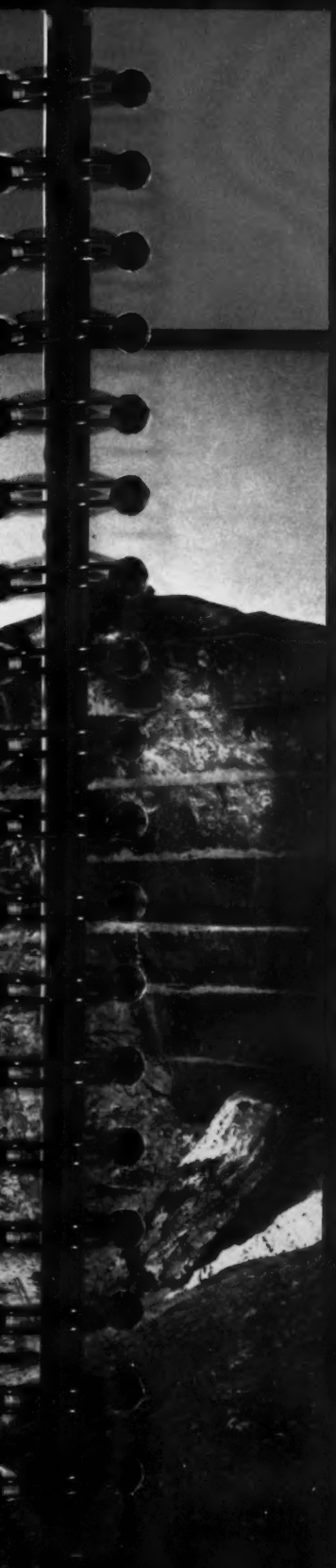
Freights

In Some Sectors Demand For Tonnage Exceeds Supply

EXPORTS of Lacq sulphur from Bayonne have to some extent been inhibited so far as distant markets are concerned, by an inability to charter big ocean-going ships owing to limited depth of water in the River Adour. Operating costs per ton per mile, and in consequence, the freights demanded by shipowners, are substantially lower for vessels of 12,000 tons and upwards than for those of under 6,000 tons, hitherto the maximum acceptable at Bayonne. Long-term plans of port improvement to facilitate the heavy import traffic in steelmaking ores at neighbouring Le Boucau will certainly make the area more attractive to shipping. Already some betterment can be observed from the fact that this month a vessel left Bayonne with 7,790 tons of sulphur for Cochin. She was booked at 64s. 1d. a ton (on f.i.o. terms), which compares favourably with 70s. paid for a 5,500-tonner to Bombay in July, when the freight market generally was weaker. But, for the present, the great strength of Lacq lies in the nearer markets, especially in the U.K. and even more so Scandinavia, where many users cannot or do not wish to receive more than a few hundred tons at a time either because works are situated adjacent to small ports or storage facilities are inadequate.

Recent charterings of small coasters from Bayonne to such places as Greaker, Halmstad, Raumo, Slottsbron and Skutskar have been

Pyrites....



THE THARSIS SULPHUR AND COPPER CO. LTD.

COMPAÑIA ESPAÑOLA de MINAS de RIO TINTO S.A.

Pyrites is a stable, assured and competitive source of sulphur. The Rio Tinto and Tharsis mines in Spain have supplied pyrites for over eighty years. Their known reserves are unrivalled.

← The Tharsis Company Calañas Opencast showing the silos face.

...Europe's principal source of sulphur

made at freights equivalent to between $4.30 to $4.70 in lots of 600 to 900 tons. Rates for bulk-carrier from the Gulf to Near Continent have advanced to about $4.60 f.i.o. and smaller parcels, such as that booked a few weeks back, of 4,000 tons from Beaumont or Port Sulphur to Rouen at $6.60 f.i.o., attract higher rates.

An interesting fixture done at the end of August was for a 9,500-tonner from Port Moody B.C. to Formosa, at $7.50 a ton excluding costs of loading and discharging. On present freight markets Canadian sulphur would appear to enjoy a freight advantage for S.E. Asian ports, India and Australasia of $2.50 to $4.00 a long ton.

Pyrites Sector

In the pyrites sector trade continues from Cyprus and the Iberian Peninsula to conventional destinations in North-West Europe at rates of freight showing little, if any, advance on those prevailing in the depths of the slump. In fact, the rate secured by Belgian receivers, chartering from Huelva and Setubal at 20s. 6d. a ton, less the customary deductions of 2s. 6d. (or 10 Escudos) for loading and 2s. 6d. for discharging, is the lowest for the past 12 years. In these cases the main reason why freights have not responded to the world-wide uplift in all other markets is that the ships so engaged do not have the freedom to seek more profitable employment elsewhere.

Demand for Dry-Cargo

In general demand for dry-cargo ships is showing no signs of any fall-off—and in some sectors demand for tonnage already exceeds supply. The present "laid-up" fleet, including a bare dozen of modern ships, offers no cushion against really big gains in freights should any additional, urgent call for tonnage develop this winter.

The following freight statistics are based on known charterings, save where recent reports are lacking. In such cases "notional" figures, calculated on freights paid for other commodities moving in the same direction, are inserted:—

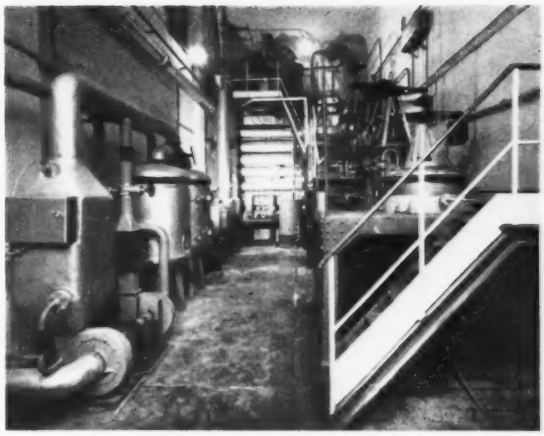
EXPORTING AREA	DESTINATION	FREIGHTS PER LONG TON (Month of September)		
		1961	1960	1959
U.S. Gulf/Mexico	United Kingdom[1]	57s. 6d.	47s. 6d.	45s. 0d.
,, ,, ,,	N.W. Europe[2]	$5.50	$5.00	$4.75
,, ,, ,,	India[3]	$10.25	$9.75	$9.05
,, ,, ,,	Australasia[3]	$12.50	$11.02½	$9.75
,, ,, ,,	Brazil[4]	$7.25	$5.50	$4.75
Bayonne	N.W. Europe[4]	20s. 0d.	19s. 0d.	16s. 9d.
,,	United Kingdom[1]	33s. 6d.	33s. 0d.	26s. 0d.
Huelva	Antwerp[5]	20s. 6d.	24s. 0d.	22s. 6d.
Cyprus	Rotterdam[5]	26s. 0d.	25s. 0d.	24s. 6d.
,,	United Kingdom[6]	40s. 6d.	37s. 6d.	37s. 9d.

KEY TO CHARTERING CONDITIONS:—

1 Cargo f.o.b.—ship to pay current cost for discharging.
2 Shipowner to pay 50 cents per ton for loading and 40 cents (U.S.) per ton for discharging.
3 Ship pays 50 cents per ton for loading and current rate for discharging cargo.
4 Cargo f.i.o. (no charge to ship for loading or discharging).
5 Ship pays 2s. 6d. per ton for loading and 2s. 6d. ton discharge.
6 Ship pays loading cost 2s. 6d. per ton and for discharging the rate current at destination.

Sulphurex Continuous Sulphonation Process

Uses sulphur trioxide instead of oleum or other sulphonating agent



General view of the Sulphurex plant at Alcamir S.p.A. The scrubbers are at the top middle back. On the right are the sulphonators and flushing units and on the far left the sulphur burner

DEVELOPMENT of the market for synthetic detergents has lead to new sulphonation techniques. In 1954 the first continuous sulphonation process which utilized oleum as sulphonating agent was patented by Ing. Mario Ballestra in Italy. This process has since been further developed and plants utilizing it have been and are being constructed by Oronzio de Nora of Milan, Italy. United Kingdom agents for the new process which uses sulphur as raw material are John A. Hewgill Ltd., of London.

Known as the Sulphurex Process, continuous sulphonation is effected by sulphur trioxide obtained by burning molten sulphur. It eliminates all intermediate sulphonation agents, use of excess material and production of by-products. Moreover, cost of sulphonation is reduced and liquid detergents can be produced with a very low sodium sulphate content — less than 3%.

Plants using the Sulphurex Process

There are 12 plants throughout the world either in operation or under construction by Oronzio de Nora employing the Sulphurex Process. These are shown in the table below.

De Nora SO_3 Plant

Oronzio de Nora have developed a simple method of making gaseous SO_3 direct from sulphur. Powdered sulphur of a high purity, minimum 99.5% S, is fed directly into the steel reaction vessel and melted by steam heating. An electric steam-jacketed proportioning pump regulates the flow of sulphur to the combustion chamber where the sulphur is burned with a controlled quantity of pre-filtered air, dried in a silica gel drying unit comprising two dryers connected in parallel, and then blown into the combustion chamber.

Hot SO_2 gases from the burner flow through a cast iron heat-exchanger which is equipped with a by-pass for temperature control. Before entering the converter gases pass through a hot gas filter. Conversion to SO_3 is effected in a three-pass Monsanto converter

Continuous Sulphurex Process Plants

Country	Company	Capacity
Austria	Persil Gesellschaft mbH, Vienna	500 kg./hr.
Belgium	S.A. Adjubel, Lembecq-Hal. n. Brussels	250 kg./hr.
Czechoslovakia	Strojimport	500 kg./hr.
France	Ets. Collette & Foucher, Issy-Les-Moulineaux, Seine	250 kg./hr.
Germany	Persil Gesellschaft mbH	500 kg./hr.
Iraq	Unilever Ltd. (Cotton Steel Products), Bagdad	500 kg./hr.
Iraq	Vegetable Oil Extract Co., Bagdad	250 kg./hr.
Italy	A.E. Bianchi & Co., Rho, Nr. Milan	500 kg./hr.
Italy	Alcamir S.p.A., Milan	100 kg./hr.
Mexico	La Luz	300 kg./hr.
Mexico	Pemex, Mexico City	100 kg./hr.
Saudi Arabia	Modern Industries Co.	250 kg./hr.
Thailand	Unilever Ltd.	250 kg./hr.

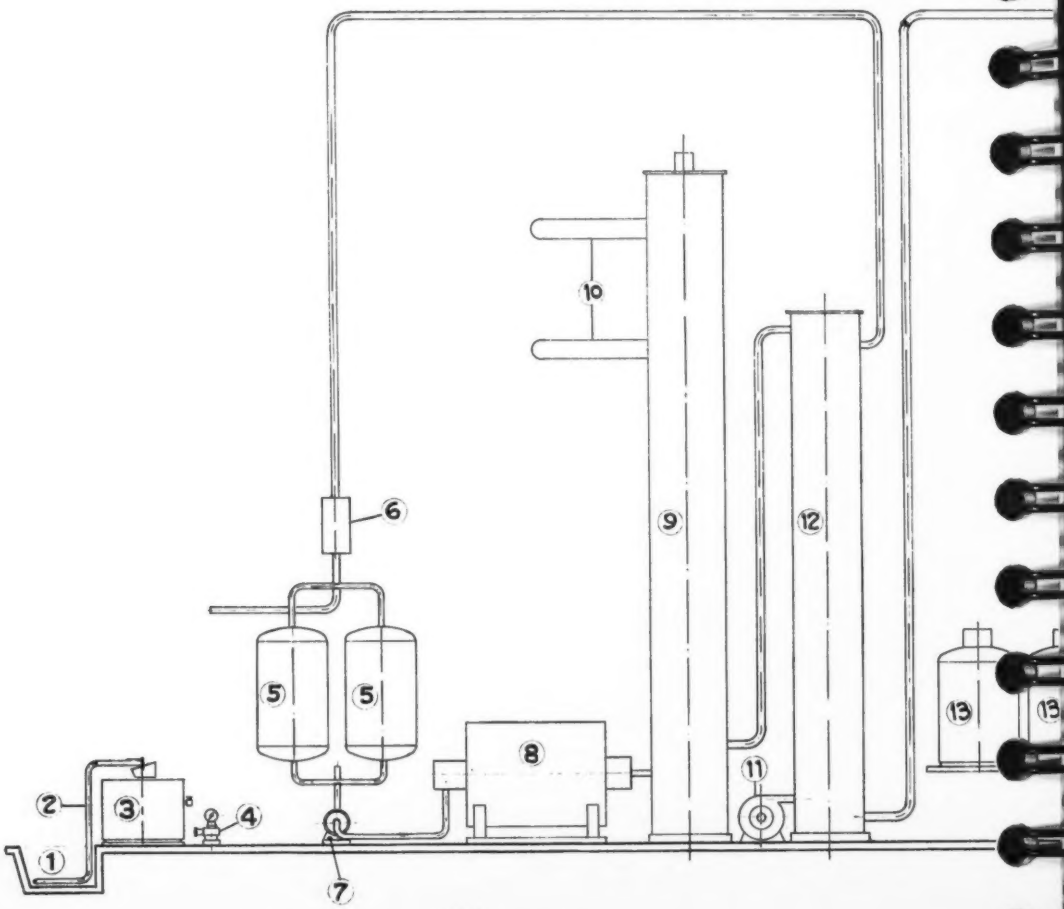
of four layers of Monsanto vanadium sulphuric acid catalyst carried on grid supports. After passing through the first two layers the gases are cooled in two duct heat-exchangers, each provided with a by-pass. At the converter, SO_3 is cooled in a tube-type heat-exchanger and after being cooled to 60°C is used directly at 2,000 mm. pressure (water gauge) as sulphonating agent.

A centrifugal fan blows atmospheric air into the heat-exchangers so that SO_3 is cooled countercurrently and the air is heated to 250°C. The same fan blows heated air to the silica gel drying unit during regeneration. Should this fan stop for any reason, a safety device immediately arrests the sulphur pump.

As the flow of sulphur is constant and the percentage of SO_2 at the converter inlet is constant, the converter gas volume — air/SO_3 ratio — is also constant.

A special electric pre-heater is used during start-up operations to raise catalyst temperature to the operation point. Control of operating

Flow diagram of the Sulphurex process for continuous sulphonation with SO_3 from sulphur. (1) Sulphur storage tank; (2) chain conveyor; (3) sulphur melting unit; (4) sulphur proportioning pump; (5) silica gel group; (6) air filter; (7) compressor; (8) sulphur burner; (9) catalysis tower; (10) cooling units; (11) fan; (12) heat exchanger; (13) service vessels; (14) raw material proportioning pumps; (15) fan; (16) scrubbers; (17) collecting tanks; (18) pumps; (19) first sulphonator; (20) second sulphonator; (21) ageing crutcher; (22) product finishing unit; (23) neutralizer; (24) final vessel; (25) pump for neutralized product; (26) sulphonation degree control unit; (27) pH meter



Sulphurex and Oleum Process Compared

	Oleum Process	Sulphurex Process
Sulphonating agent	Oleum	Sulphur (for SO_3)
Characteristics	Corrosive liquid	Inert powder
Supply	Tanks, drums	In bulk (powder)
Storage	Tanks, drums	In bulk (powder)
Acid purification	Washing & separation	No purification required
By-products	Dark 70% spent sulphuric acid	No by-products but possibility of obtaining sulphuric acid
By-products storage	Lead-lined tanks	Steel tanks

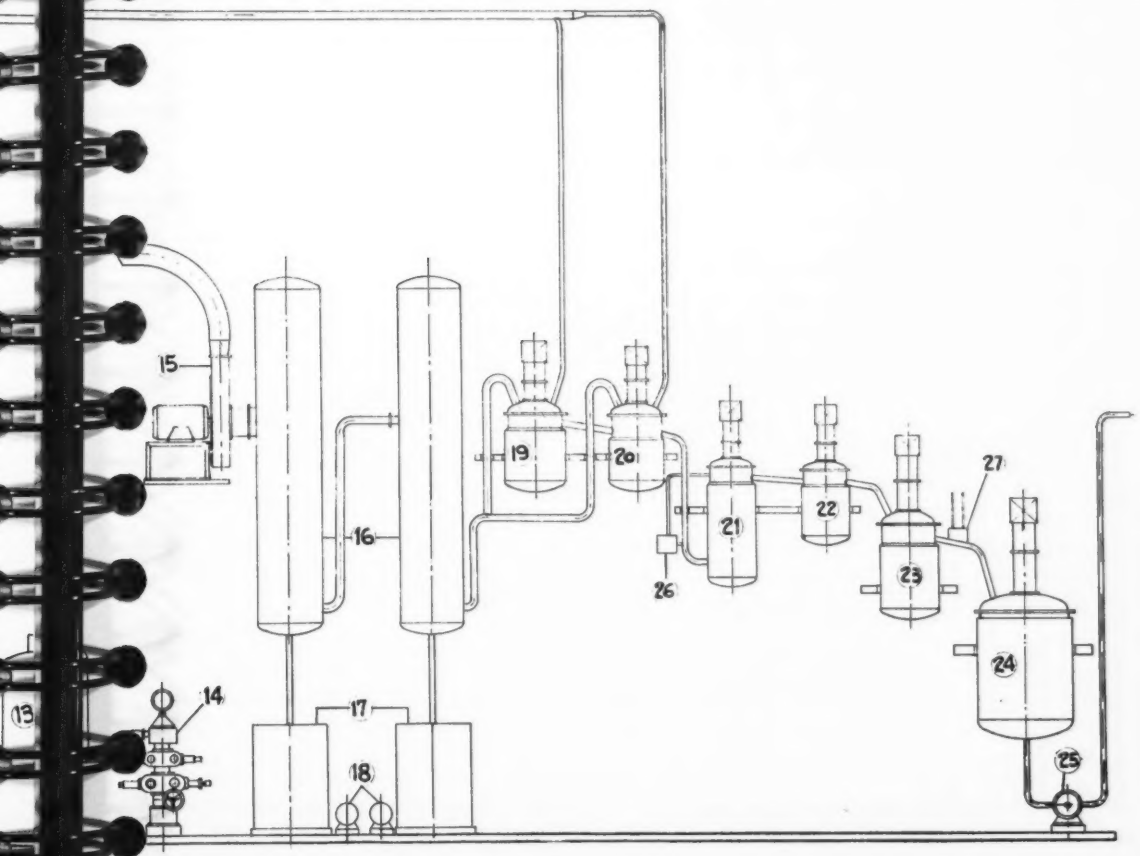
Raw Material Consumption

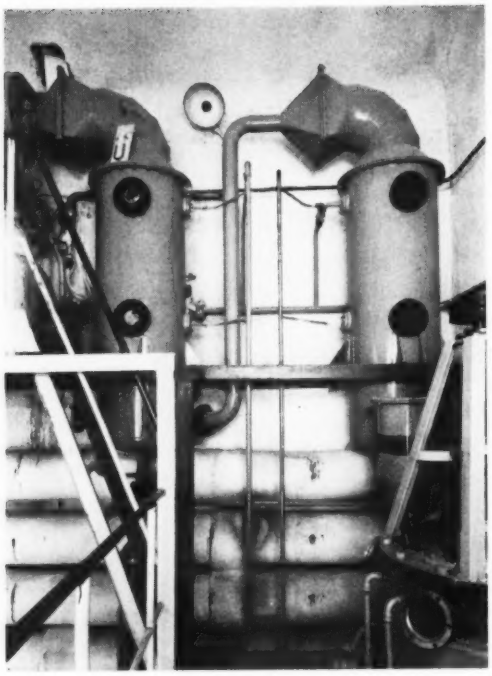
per 100 kg. 100% active product

	Oleum Process	Sulphur Process
Dodecylbenzene	72 kg.	72 kg.
Sulphonating agent	oleum 80 kg.	sulphur 11½ kg.
Soda	16 kg.	13 kg.

Product

	Oleum Process	Sulphurex Process
Active substance	100 kg.	100 kg.
Sodium sulphate	10-15 kg.	2-3 kg.
Unsulphonated material	1.5 kg.	1.5 kg.
Colour	white	white
Smell	characteristic alkylate smell	no smell
Appearance	non-homogenous	homogenous
Usefulness for powder detergents	good	good
Usefulness for liquid detergents	difficult, expensive with additives	ideal, without additives





Scrubbers at the Alcamir plant

conditions of the part of the plant generating SO_3, i.e. temperature, pressure and degree of conversion, is automatic, the latter by a new patented device. Conversion of up to 99% is claimed.

Sulphonation

In the sulphonating system SO_3 is used directly and is dispersed and completely absorbed in the reaction mass. The reaction vessels are of stainless steel and include temperature controls and special agitators to ensure uniform reaction and heat transfer.

In the Sulphurex process the degree of sulphonation is decisive — excess of SO_3 leads to discolouration and free acid content, while too little SO_3 causes a high percentage of material to remain unsulphonated.

Control is automatic by a new device which indicates at any time the percentage of unsulphonated matter in the reaction mass. It not only provides continuous determination and registration of the sulphonation degree to within ±0.5% but also corrects automatically any deviation from the desired sulphonation by varying the alkylate inflow in relation to the quantity of SO_3.

Sulphonation is completed in an ageing crutcher and the sulphonated product passes to a stabilising vessel. Acid from the sulphonation process is neutralized directly in a special neutralizing vessel. No washing or separating operations are required prior to the neutralization step and no spent acid results. Continuous alkalinity regulation is effected by an automatic pH control servo - mechanism which acts directly on the alkali measuring pump, thus ensuring a constant pH. Air from the sulphonator is passed through two absorption and scrubbing towers to purify it before release to atmosphere. Alkylate is used in the first tower to recover any SO_3 that may have escaped from the sulphonator. Sodium hydroxide is used in the second tower, to eliminate traces of SO_2.

Advantages Claimed

It will be noted from the results that the product obtained using the Sulphurex Process compares favourably with the oleum process. The Sulphurex Process, however, can be used for sulphonating fatty alcohols. It can also be employed in co-sulphonation of alkylbenzene with xylene or toluene and various other sulphonation processes.

Expanding U.S. Sulphur Demand in Second Half 1961

But U.S. Frasch producers apprehensive about the future

- U.S. chemical producers now second largest consumers of sulphuric acid.
- More sulphuric acid plants in operation.
- Wet-process phosphoric acid manufacture expected to consume 3·2 m. s. tons sulphuric acid in 1961.

EXPANDING industrial activity in the U.S. is being reflected by growing sulphur demand and despite the low level of consumption during the first half year when many sectors of industry were still labouring under the after-effects of the recession, U.S. consumption of sulphur in 1961 is expected to reach, if not slightly exceed, six million tons.

The outstanding feature of the sulphur industry, however, is the rate of new constructions of sulphuric acid plants, virtually all designed to meet the needs of wet-phosphoric acid diammonium phosphate manufacture. By the end of this year it is expected that installed sulphuric acid capacity may reach 25 million s. tons (H_2SO_4), some 2.5 million s. tons more than at the start of 1960.

Frasch Sulphur

U.S. Frasch sulphur producers increased their level of operations by about 10% from the second quarter onwards. The promise of increased sulphuric acid production offers prospects of a further improvement in the employment of available dome capacity although in view of the constant increase of competitive supplies on world markets as well as at home, where the problem of Canadian recovered sulphur looms larger, any expansion of output is not expected to be substantial.

Output originated from 12 domes, of which five are worked by the Freeport Sulphur Company, four by Texas Gulf Sulphur Company and one each by Jefferson Lake Sulphur Company, Duval Sulphur and Potash Company and U.S. Sulphur Company. The emphasis on molten sulphur deliveries continues to increase and of this year's deliveries of U.S. Frasch sulphur 50% will be in this form.

The hurricane "Carla" which swept the Gulf Coast does not appear to have caused significant damage to the sulphur industry. None of the domes was exposed to the centre of the hurricane although Orchard Dome was near it and is understood to have suffered some damage. The only severe damage was suffered by the loading installations at Galveston which are serving Jefferson and Duval. Including Grand Isle which is closed and evacuated when there is a pertinent hurricane warning, work at all domes could be resumed within 24 hours and Galveston became operative within seven days.

Production. Frasch sulphur production in the first half of 1961 totalled 2,603,700 tons, an increase of 173,541 tons (7.1%) compared with the same period of 1960.

Apparent Sales. In the first six months under review apparent sales of Frasch sulphur totalled 2,442,372 tons, about 103,000 tons (4%) less than in the same period of 1960. Exports, contrary to earlier reports, declined and deliveries by Sulexco which exclude shipments to Canada and Cuba were 38,000 tons (6.8%) lower than in the first half of 1960.

Stocks. Throughout the first half of 1961 stocks have risen and at the end of June amounted to 3,936,313 tons, an increase of 3.5%.

Recovered Sulphur

Output of recovered sulphur from oil refineries and natural gas cleaning plants during the first six months totalled 416,335 tons, an increase of 66,650 tons (+19%). Apparent sales of recovered sulphur, in contrast to the decline in Frasch sulphur sales, continued to rise and the total of 419,373 tons represents an increase of 39,561 tons (10.4%) and is the highest on record. Stocks totalled 106,429 tons

at the end of June, 3.4% less than at the end of June 1960.

Trade

Imports. The United States imports of brimstone in the first half year totalled 398,822 tons, a decline of 15,366 tons (3.7%) compared with the same period in 1960. Imports from Canada advanced slightly to 93,453 l. tons but those from Mexico were substantially lower, amounting only to 305,369 s. tons, a decrease of 47,080 s. tons compared with the same period in 1959.

Exports. Exports of Frasch sulphur during the first half-year totalled about 760,000 tons. Shipments to Canada, where almost the entire brimstone requirement of the Eastern provinces is supplied from the U.S. Gulf, showed little change. There were, however, no shipments to Cuba, previously an important market (20,000 tons). Exports to Western Europe, Sulexco's largest market, declined substantially as the result of subdued activity in the chemical industry, reductions of consumer stocks and the increasing level of sulphur deliveries from France, where Societe Nationale des Petroles d'Aquitaine at Lacq is now in full production. Compared with the first half of 1960, Sulexco shipments to the U.K. declined by about 34,000 tons, to the Netherlands by about 17,000 tons, to Switzerland 10,000 tons, although those to Western Germany remained unchanged. The impact of competition from French sulphur also made itself felt in Tunisia, where, compared with shipments of over 15,000 tons in the first half of 1960, this year there were none.

The largest increase by Sulexco was recorded in shipments to Brazil, which rose 20,000 tons to 78,000 tons. Of other important U.S. export markets, shipments to Australia rose 6,000 tons to 61,000 tons, but those to New Zealand (−1,500 tons) and S. Africa (−3,500 tons) failed to reach last year's level.

Another notable gain in export deliveries was made by the resumption of deliveries to Israel of about 10,500 tonnes. Exports to India rose 5,000 tons to about 69,000 tons and the progressive expansion of demand, which is to be stimulated by investment in fertilizer projects by Sulexco, makes India an increasingly important market.

Of the exports to Iron Curtain countries, those to Czechoslovakia have continued, but those to Poland, which in the first half of last year amounted to 3,000 tons, have ceased, as the result of the increasing domestic sulphur production.

Consumption

Favourable indications of growing sulphur demand in most sectors of U.S. industry have been apparent since the early summer. In the first half of this year consumption of sulphur in all forms declined to an annual rate of about 5.9 million tons as the result of continuing industrial recession notably in the first quarter. Besides the restricted level of operations of the steel industry and difficulties in many chemical sectors, notably pigments, the impact of bad weather adversely affected the fertilizer industry.

Apparent consumption of brimstone in the first half of 1961 totalled 2.5 million tons, slightly more (+0.9%) than in the same period of 1960, but actual consumption, comparing the results of the principal consumers, is estimated to have been about 2% to 2½% below that of the first half of 1960. Sulphuric acid production shows a decline of 4.2% but several non-acid sectors show improvements.

Output of special and alpha-dissolving pulps has increased following the bad year in 1960, and carbon disulphide manufacture has increased by about 4%. Sulphur demand in the rubber industry has continued to decline, due to the recession in the U.S. car industry.

Sulphuric Acid

Production (gross) of sulphuric acid in the first six months of 1961 totalled 9,011,928 s. tons (100% H_2SO_4), a decrease of 3.9% compared with that in the first half of 1960. Virgin acid production amounted to 8,603,956 s. tons, a decrease of 373,230 s. tons (−4.2%).

Output of spent acid increased, and at 407,972 s. tons, was 2.2% higher, but the trend in this sector is recessive or at best static, mainly as the result of changes in the level of sulphuric acid requirements for alkylation. By-product sulphuric acid output at metal smelters is estimated at 600,000 s. tons, an

SULPHURIC ACID PRODUCTION

	Jan./June 1960	July/Dec. 1960	Jan./June 1961	Difference Jan./June 1960/61	% Change
TOTALS	**9,376,266**	**8,443,359**	**9,011,928**	**−364,338**	**−3.9**
Chamber	1,092,672	788,011	955,701	−136,971	−1.3
Contact	8,283,594	7,655,348	8,056,227	−227,367	−2.7
SPENT ACID	399,080	394,504	407,972	− 8,892	−2.2
NEW ACID TOTAL	8,977,186	8,048,855	8,603,956	−373,230	−4.2
Chamber	1,092,672	788,011	955,701	−136,971	−1.3
Contact	7,884,514	7,260,844	7,648,255	−236,259	−3.0
Oleum	903,328	889,175	932,193	+ 28,865	+3.2
Other than Oleum	7,380,766	6,766,173	7,124,034	−256,732	−3.5

	1960				1961			
Comparison of	**March**	**April**	**May**	**June**	**March**	**April**	**May**	**June**
Gross Total	1,619,055	1,556,371	1,614,152	1,495,438	1,562,807	1,540,382	1,573,952	1,452,107
Chamber	198,961	182,353	186,888	149,888	176,569	171,601	165,594	122,793
Contact	1,420,094	1,374,018	1,427,264	1,345,550	1,386,238	1,368,781	1,408,358	1,329,314
Spent Acid	69,720	68,148	68,784	63,742	68,638	66,509	71,721	71,433

increase of about 10% over the same period in 1960.

The acid industry has continued to operate at about 75% of capacity, a low level compared with the decade up to 1958. In the first half of 1961, only 9% of output originated from chamber plants, which play a progressively declining part in the industry. Practically all the plants built during the past 10 years and those under construction or planned are contact type units.

New facilities planned for 1961 are estimated to add about 1.5 million s. tons to U.S. sulphuric acid capacity, which by the end of this year should total 25 million s. tons (100% H_2SO_4). At the start of 1961, capacity for new sulphuric acid was estimated at 3.5% greater than at January 1960—the smallest gain since the sulphur shortage of the Korean War year 1952—but the current expansion phase is once more re-establishing the trend in the rate of new constructions. The greater part of the new capacity is being constructed for captive use in the manufacture of wet phosphoric acid and superphosphates. Developments are centred in Florida and the U.S. Midwestern and Western States.

In 1960 production of sulphuric acid totalled 17.1 million s. tons (100% H_2SO_4). The South further advanced its leading position and in 1960 accounted for 50%—Florida alone represented 13.3% of total acid output. The North Central region is the second largest (21.2%), with Illinois (7.9%) as the leading state. The Middle Atlantic Division (14.3%), the West (13.4%) and New England (1.1%) account for the balance.

Consumption of Sulphuric Acid

The largest consumer of sulphuric acid in the U.S. continues to be the fertilizer industry. In the first half of this year it is estimated to have used 3.7 million s. tons (100% H_2SO_4) or about 38% of the gross consumption of sulphuric acid in this period. This increased consumption is the result of the boom in wet process phosphoric acid manufacture—12% higher than in the first half of 1960—which has, however, not made up for the reduced sulphuric acid demand for ammonium sulphate and single superphosphates production. The following table shows the results of the phosphate fertilizer industry:—

July-June
Short tons 100% A.P.A.

	1961	1960	% change
Total production	**2,647,466**	**2,664,369**	**− 1**
Normal and enriched	1,231,934	1,365,606	−10
Concentrated	1,012,335	935,019	+ 8
Other phosphatic fertilizer materials	403,197	363,744	+11

Of the output of phosphoric acid in fertilizers it is estimated that all but about 150,000 s. tons is based on phosphorus, the balance being wet process acid.

Chemical producers are the second largest consumers of sulphuric acid, taking an estimated 1.9 million s. tons in the first half of the year. In particular, strong demand has been noted in synthetic detergents, phenol, alum and hydrofluoric acid manufacture. Oil refining,

however, is estimated to have used about 10% less sulphuric acid than in the preceding year, mainly due to the increasing application of solvent-extraction and hydrogenation. Alkylation, a major user in the oil refining industry, is not expanding, mainly due to the changeover in aviation fuel from high octane to kerosene type fuels and the growing application of hydrofluoric in place of sulphuric acid.

Production of titanium dioxide was restricted as household paint demand declined. The start of a new plant at New Johnsonville by E.I. Du Pont de Nemours and Company based, like the bulk of this company's titanium production, on the chlorine route, is, however, unlikely to affect the overall picture in this sector of the acid-using industries. Acid demand for steel pickling and non-ferrous processing has increased slightly.

The downward trend noted at the end of 1960 in textile and tyrecord uses of rayon has continued. Acid requirements were lower but those of transparent paper have increased and can be expected to rise still further.

Manufacture of synthetic fibres and other products is consuming increasing quantities of sulphuric acid, notably caprolactam and methacrylates; the resultant by-product ammonium sulphate contributes increasingly to the overall supply.

Outlook

United States economy in the first half of 1961 started on a cyclical upturn. Having declined to a "low" point in February 1961, the Federal Reserve index of industrial production has since continued to advance reflecting increased output and a better employment situation.

The gross national product in the second half of 1961 is expected to average about 4.5% better than in the first half-year and industrial production is expected to rise by just over 6%. A broad and substantial improvement, however, is expected in 1962. On present trends, consumption should approach and perhaps exceed six million tons sulphur in all forms. Increased demand for sulphuric acid should provide the main stimulus to greater sulphur consumption and it is expected that requirements of the fertilizer industry will account for most of the growth in sulphuric acid use. As indicated on the project list below, the greater part of new U.S. sulphuric acid production will be captive and used for conversion of phosphate rock to high analysis binary complex fertilizers—in particular diammonium phosphates. Wet process phosphoric acid manufacture is expected to consume 3.2 million s. tons sulphuric acid in 1961, some 14% more than in 1960 and nearly one-quarter more than in 1959.

Diammonium phosphate manufacture, which accounts for most of the increase in phosphoric acid capacity, is considered by the sulphur industry to be the most important new fertilizer since the introduction of triple superphosphate, especially as it requires about 40% more sulphuric acid per unit of P_2O_5 than triple superphosphate and as almost every U.S. phosphate producer is now considering the future potential of this fertilizer.

The use of sulphuric acid in ore treatment received a major boost in the mid-1950's when

New U.S. Sulphuric Acid Plants in Operation or Under Construction

Company	Site	Capacity	On stream
Allied Chemical Corp.	East St. Louis, Ill.	50,000 tons/year	In operation
National Phosphate Co.	Marseilles, Ill.	100,000 tons/year	Under construction
American Cyanamid Co.	Brewster, Fla.	400,000 tons/year	October 1961
Valley Nitrogen Producers	—	16,500 tons/year	
American Agricultural Co.	—	Doubling capacity	1961
Bunker Hill Chemical Co.	Kellogg, Idaho	130 tons/day	March 1961
Swift and Co.	Fla.	175,000 tons/year	May 1961
Olin Mathieson Corp.	Joliet, Ill.	50,000 tons/year	1961
Tennessee Corp.			
U.S. Phosphoric Division	Tampa., Fla.	Doubling capacity	Late 1961 or early 1962
Collier Carbon and Chemical Co.	—	130 tons/day	March 1961
Blockson Chemical Co.	—	50,000 tons/year	1961
Monsanto Chemical Co.	—	—	1961
Climax Chemical Co.	Hobbs, N.M.	150 tons/day	May 1962

New Phosphoric Acid Plants in the United States of America

Company	Site	Capacity	On stream
American Agricultural Co.	—	Double output in 1961	
Monsanto Chemical Co.	—	June 1961 producing 105% acid under name Phospoleum Also 85 and 75%	
Allied Chemical Corp.	N. Claymont, De.		Early 1961
Bunker Hill Co.	Kellogg	130 tons/day	March 1961
Collier Carbon and Chemical Corp.	—	130 tons/day	March
Blockson Chemical Co.	—	50,000 tons/year	$1.5m. expansion due 1961
Olin Mathieson Corp.	Joliet	50,000 tons/year	75% acid due 1961
Armour Agricultural Chemical Co.	Cherokee, Ala.		
N.W. Co-operative Mills Inc.	St. Paul, Min.	100,000 tons/year	Projected
Virginia Carolina Chemical Corp	Nicholas, Fla.	100,000 tons/year	Expansion
U.S. Phosphoric Products Inc.	E. Tampa	200,000 tons/year	Doubled
Davidson Chemical Corp.	Ridgewood		1962
National Phosphate Co.	Marseilles, Ill.	70,000 tons/year	Projected
International Mineral and Chemical Corp.	Bonnie, Fla.	100,000 tons/year	1962
Coastal Chemical Corp.	Pascagoula	116,000 tons/year	Expansion
Swift and Co.	Agricola		Project

it became the preferred leaching agent of uranium ore treatment. Now Beryllium Corporation appears to favour an acid-leaching process for beryllium oxide ore and large-scale sulphuric acid requirements in this sector can be expected to develop. Another important acid outlet is promised by North American Coal Corporation, which is due to start recovery of alum from mine wastes in January 1962.

Despite the improved outlook for increased brimstone demand in the U.S.A., the Frasch sulphur producers are apprehensive about the future. At present the effect of higher prices in several large marketing areas and the absence of quantitative price cutting is enhancing the profitability of current operations and contributing towards the cost of the large investment in liquid sulphur shipments and distribution facilities designed to improve producers' competitive position in terms of better customer service.

The impact of Canadian sulphur on the U.S. market is seen to be looming nearer. U.S. Frasch sulphur producers hope that the bulk of shipments from Alberta will remain confined to the U.S. North West and Pacific States or move to overseas markets through Vancouver. Canadian oil and gas producers, however, are more attracted to the U.S. Great Lakes market and, following their success with Canadian railways in securing a 22% reduction of rail rates to Vancouver, now hope to get a similar concession from the U.S. authorities whom they have asked to approve a rate of $12.88 per ton to Chicago. Progressive growth of U.S. recovered sulphur supplies is already absorbing a part of the new brimstone demand, but fortunately for the U.S. Frasch sulphur industry, the greater part of new constructions occur in the Tampa region of Florida, where U.S. Frasch sulphur supplies are challenged only by their Mexican counterparts. Any loss of markets in the north to Canadian competition would, however, be a serious blow, especially as it is unlikely to pass without adversely affecting local prices, which in turn may once more upset the general price situation in other marketing areas of the U.S.A.

In overseas export markets U.S. supplies face a slight setback this year, although next year the growing world consumption promises increased shipments despite a smaller share of the market. The immediate prospect of favourable results this year and probably also next year, cannot, however, obscure from the U.S. Frasch sulphur industry the growing threat of competition from recovered sulphur, in particular that north of the 49th parallel.

Varga Process for Sulphur Removal

Hungarian development work on high-asphalt oils and tars

UTILIZATION of crudes with high asphalt and sulphur contents has become increasingly important. It is therefore of interest to note the development of the Varga process since 1951 whereby destructive hydrogenation is effected at medium pressure with catalysts — mainly iron — in suspension.

The process developed by the late Joseph Varga and his co-workers, P. Birtler, I. Karoi, B. Steingassuer and A. Zanai at the Hungarian High-Pressure Research Institute has been tried out in the laboratory and in a pilot plant.

Two-Stage Process

Varga has developed a two-stage process for hydrocracking and subsequent refining at medium pressure. In the initial stage the crudes diluted by toluene, petrol, lubricating oils, aromatic middle oils, paraffins and the like which cause greater hydrogenation to occur, are subjected to liquid-phase hydrogenation in pressure reactor (1) using a catalyst in suspension within the oil, such as iron oxide or brown-coal semi-coke. Hydrogen of 97% purity or over is added and the distillates from this stage enter another set of reactors to undergo hydrorefining in the vapour phase on a fixed-bed catalyst. Hydrogenation takes place in two pressure reactors in the third series of reactors at 30-100 (usually (50-70) atmospheres and 420 to 450°C. The product leaving the last reactor passes two hot separators (5) where heavy oils and catalysts leave the system. Light components with the circulating gas enter two refining reactors in series 6, containing catalysts in fixed beds, with interheater (4); between the reactors. On leaving the vapour phase hydrogenation, the circulating gas enters a scrubber to separate light hydrocarbons.

The combined process has been tried on the following crudes — Hungarian crude oil, a 50% residue of Tuymazin oil, brown-coal tar and shale oil. Data and results for 50% residue of Tuymazin oil were as follows:—

Density at 25°	0.934
Asphalt content	1.75%
Conradson test for coke formation	8.4
Sulphur content	1.88%
Operating Conditions:	
Pressure (atm)	70
Temperature (°C)	435
Diluted with kerosene	4.1
Results:	
Gas and losses	8.2%
Petrol (up to 190°C)	9.9%
Gas oil (70°C to 330°C)	54.4%
Heavy oil (up to 520°C)	14.2%
Residue on vacuum distillation (containing catalyst)	16.6%
	103.3
Petrol:	
Density	0.745
Sulphur content	0.05%
Octane number	65.5
Gas Oil:	
Density	0.840
Sulphur content	0.15%

From these results it will be noted that the Varga process effects a very marked removal of sulphur. The octane number of the petrol can be improved by reforming and the gas oil may be used for diesel engines without further treatment. The heavy oil can be utilised for either heating purposes or coke production.

Advantages Claimed

Compared with simple cracking the Varga combined stages method gives higher yields of liquid fuels with better qualities and compared with high pressure hydrogenation, the new process is stated to be cheaper in both primary and operating costs. The advantage over coking consists in a simpler flowsheet and in obtaining a residue more valuable than coke. Heavier crudes can be treated at lower pressures, temperatures and hydrogen consumption than is possible using high-pressure hydrogenation. Also, the high molecular components of heavy crudes are cracked without significant formation of coke and gas.

Process waste gases contain substantial quantities of hydrogen sulphide and based on the conditions outlined above recovery of 18 kilos sulphur per ton of residue treated appears to be practical.

Pyrite Recovery from Old Mill Tailings

Denver flowsheet study

PYRITE has long been used as a source of sulphur, and its recovery as a by-product from the flotation of certain base metal ores is a well established practice.

Significant amounts of pyrite, however, are contained in large tonnages of mill tailings which have accumulated as a result of various milling operations. In many instances these tailings can be treated to yield pyrite concentrates containing at least 48% sulphur and providing a suitable source of sulphur dioxide for the manufacture of sulphuric acid. Given reasonable access to markets, recovery is worthwhile.

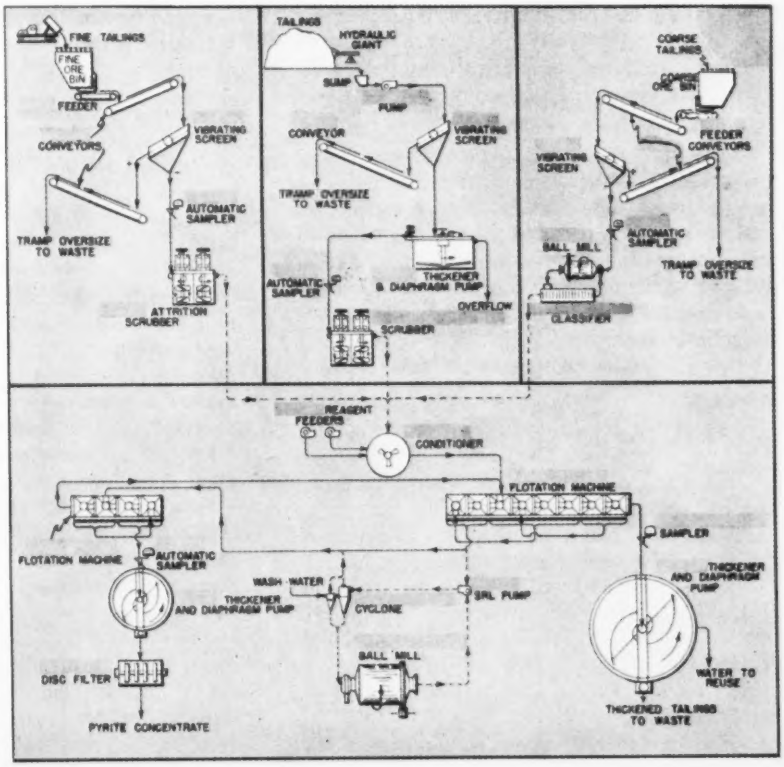
Pyrite recovery from mill tailings has been the subject of a special study by Denver Equipment Company, Denver 17, U.S.A. and they have produced a special flowsheet study.

Initial Treatment

Preparatory to pyrite recovery, the initial treatment depends upon the source and particle size of the material to be treated. Size reduction prior to pyrite flotation is not required for fine material, such as flotation tailings but coarse tailings, such as those produced from certain gravity concentrating operations, must be ground to provide a suitable product for flotation.

Fine Tailings

Fine tailings may either be lifted dry and transported to the mill by truck or they may be mixed hydraulically and the resulting pulp pumped to the mill. Screening of the tailings is required prior to treatment to remove oversize and debris.



Denver flowsheet study for pyrite recovery from old mill tailings

Surfaces of pyrite contained in old mill tailings are frequently oxidized to such a degree that recovery by flotation may be necessary to produce a satisfactory pyrite product with acceptable purity. Denver have accomplished removal of the oxidized surface films by scrubbing at densities of from 70-80% solids in a special attrition scrubber developed by the company. This scrubber is equipped with specially designed rubber covered turbine-type propellers which promote an intense inter-particle scrubbing action and hence removes the undesirable oxidized coatings from the pyrite.

Tailings lifted dry may be diluted with water to the proper consistency for scrubbing. Hydraulically mined tailings normally require thickening to remove excess water prior to the high-density scrubbing.

Coarse Tailings

Tailings in which the pyrite is not free from associated minerals or which is too coarse to be handled by flotation as lifted, has first to be reduced to the proper particle size by grinding. For this Denver suggest a steel head ball mill in closed circuit with spiral or rake classifier.

Conditioning

Scrubbed tailings, or the classifier overflow from the grinding circuit, flow to a super agitator and conditioner where reagents are added to activate the pyrite. Normally a xanthate or dixanthogen-type collector is used. As pyrite generally responds most satisfactorily to activation in an acid circuit, sulphuric acid in sufficient quantity to produce a pH of 6 or below is added to the conditioner.

Flotation

From the conditioner the pulp flows to a flotation machine. The cells of this are arranged to provide for roughing, scavenging and one stage of cleaning, and then final cleaning. The scavenger froth is returned by gravity to the second rougher cell for retreatment. The rougher froth flows to the first-stage cleaner cells. If middling particles are present the froth from the first-stage cleaner cells is reground in a regrind ball mill operating in a closed circuit with a Denver-Morton cyclone classifier.

The classifier overflow is pumped to the final flotation cleaner cells. Since the final cleaning of pyrite may be carried out at a pH of from 6.5 to 7.0, time may be added to the regrind circuit to neutralize the excess acid, thus avoiding the expense of having acid-proof equipment in this part of the processing.

Final cleaning normally consists of two stages with the cleaner tailings being returned to the head of the rougher flotation circuit.

Thickening and Filtering

To remove excess water prior to filtering, the cleaned pyrite flotation concentrate is pumped to a spiral rake thickener. An adjustable stroke diaphragm pump, mounted on a thickener superstructure, meters the thickened pyrite to a disc filter. This filter is often operated only at fixed intervals; sufficient thickener capacity is provided to adequately store the concentrates accumulated during filter shut-downs. The adjustable diaphragm pump is used for recirculation of the thickened solids during such periods.

If it is required to reclaim water for re-use, the rougher flotation tailings are thickened in a spiral rake thickener, and plant water is reclaimed.

Processing Economics

Economics of processing tailings depends on many factors, which are apt to vary throughout tailings deposits. Careful and extensive sampling of the tailings deposit is therefore essential. Denver have found it preferable to carry out small-scale batch tests followed by pilot mill tests to ensure that the mill has the flexibility to meet the changeable composition of the mill feed. Since one mill may handle tailings from several dumps in an area, a complete knowledge of all deposits if necessary so that adequate facilities and flexibility of the process may be incorporated in the mill.

It is not easy to estimate the cost of treatment without detailed knowledge of the tonnage to be treated. As a rough guide, however, a plant to handle 100 tons a day of tailings using a flowsheet such as that described above would cost for the main equipment items about £30,000. Installed cost of a plant including all ancillary equipment, services and buildings would be in the region of £50,000 to £60,000.

Montecatini's Major Pyrites Acid Plant at Follonica

Will include two de Nora-Monsanto H_2SO_4 units

Panoramic view of Follonica. The site of the new Montecatini pyrites treatment and 1,000 tonnes-a-day sulphuric acid plants is on the left

CONSTRUCTION has started at Grosseto, near Follonica, in the Casone District, of a major sulphuric acid plant for Soc. Montecatini which embodies new patented processes for extracting high purity ferrous iron from iron pyrites. Engineering and construction is being entrusted to Oronzio de Nora of Milan.

High-Grade Iron Residue

The Follonica plant, which will come on stream in July 1962, will be operated by the "Miniere e Cave" Division of Soc. Montecatini and, based on iron pyrites originating from the nearby Niccioletta mine, will produce annually 360,000 tonnes sulphuric acid (100% H_2SO_4) in the two de Nora-Monsanto units and 170,000 tonnes high grade iron residue. About 1,300 tonnes of pyrites a day will be consumed.

Two-Stage Roasting

Two Dorr FluoSolids roasters will be used to roast the pyrites, which will provide the sulphur dioxide for production of sulphuric acid and iron suitable for smelting. The residues from this first roaster—impure ferrous oxide—will be subjected to further roasting in the second Dorr furnace to yield Fe_3O_4 which can be upgraded by magnetic separation.

The final product will have an iron content of 65% Fe and will be pelletized by a new process. Heat generated by the roasters in the form of superheated steam will be utilised by the power station.

Acid Plants

The two de Nora-Monsanto sulphuric acid units will have a simple purification system composed of cyclones and a Peabody combined cooling and scrubbing tower, which will use sea water as coolant. Because of the high chlorine content of the sea water the plates and the baffles of the tower will be constructed of titanium. Other parts of the tower and also the SO_2 stripper are constructed of rubber-lined mild steel. A similar Peabody tower is in use at Montecatini's Porto Empedocle, Sicily, facility.

Provision for Oleum and SO_2

Additional plant will comprise electrostatic mist precipitators with selenium rectifiers, drying towers and steam turbine-driven blowers.

Both sulphuric acid units will have oleum towers for production of 35% oleum and provision will be made in one unit for liquid sulphur trioxide production.

Four Similar Units Planned

Soc. Montecatini, whose engineers have designed the new Follonica plant, expects to build four similar units in the next three years; with a total rated daily capacity of 3,000 tonnes 100% H_2SO_4.

The new plant will include the most up-to-date equipment, a large chemical laboratory, repair workshop and storage for raw material and final product. As the plant site is near the seaside resort of Follonica, special care is being taken to provide suitable fume stacks.

current events

CANADA

Molten Sulphur from Innisfail

The natural gas treatment and sulphur recovery plant of Canadian Oil Companies Ltd., at Innisfail, W. Alberta, has been in production since November 1960. A mixed gas is treated and during last May, 2,642 long tons of sulphur was produced, bringing total brimstone output since start-up of the plant to 15,202 long tons.

Little of the sulphur recovered up to date has been sold as the company have been concentrating on building up its reserves. Moreover the railway track to the plant has not so far been completed.

Some sulphur in liquid form has been shipped by road tanker to Shell Oil of Canada Ltd., at Edmonton. In May, Canadian Oil began shipping molten sulphur in insulated rail tank cars to J. C. Fennelly at California. A further 7,500 long tons of solid sulphur was despatched in June to Shell Oil.

Sweetening Process on Trial

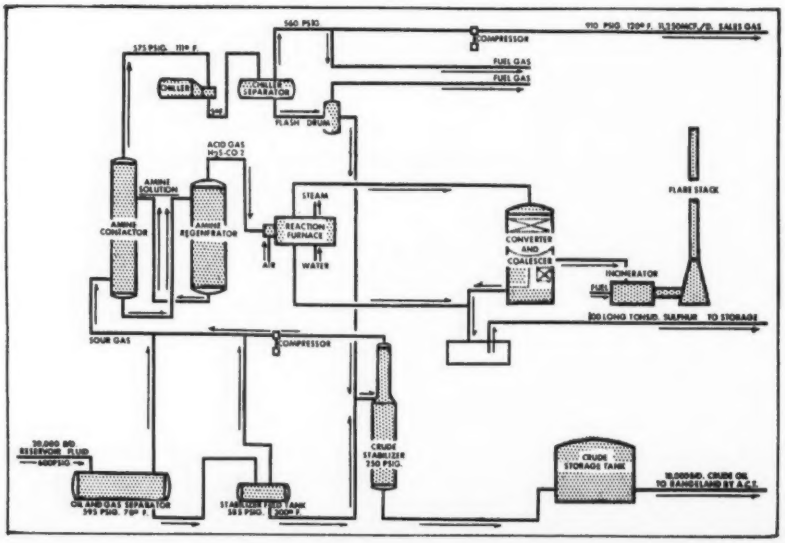
The first commercial Benfield sweetening plant in Canada operated by Imperial Oil Company at Nottingham, Saskatchewan, has been converted to the use of amine after prolonged trials with the Benfield hot potassium carbonate process failed to control hydrogen sulphide in the gas to 1gr. H_2S/100 s.c.f. It is still believed that the Benfield process can be used to sweeten sour natural gas and laboratory tests by Fluor Corporation have shown that hot carbonate solutions should be regenerable even when the H_2S/CO_2 ratio is greater than 1. A unit has been in operation at the Whitecourt recycling plant of Canadian Fina for 25 days. During the last 15 days, it is reported, H_2S concentration was held at 0.03% although H_2S content of the inlet gas varied from 12.8 to 14.2%, CO_2 content averaging 4.6%. Of the potassium carbonate in solution 78% was continuously available for acid gas removal.

INDIA

Travancore Titanium Expansion Scheme

Travancore Titanium Products Ltd., Trivandrum, Kerala, is now producing 10 tonnes a day of titanium oxide and by 1962 production is expected to reach 18 tonnes a day. Under a proposed expansion programme, daily output would be increased to 68 tonnes by 1965.

Discussions have recently been held in



Flow diagram of the Innisfail crude stabilization and gas-processing plant

London between Mr. A. G. Menon, Chief Secretary to the Government of Kerala and British Titan Products Ltd., on the question of further capital participation for the expansion.

The Government of Kerala has a majority shareholding (57%) in Travancore Titanium and British Titan holds about 22% of the shares. British Titan has decided not to increase its participation in the Indian Company. Soc. Montecatini, of Italy, however, has announced that it plans to take a holding in and place technical know-how at the disposal of Travancore Titanium.

The Indian company has a sulphuric acid plant with a daily capacity of 50 tonnes (100% H_2SO_4), but in view of its proposed expansion, consideration is being given to the construction of a new acid plant of 200 to 250 tonnes a day capacity.

UNITED STATES

Research on Continuous Sulphite Pulping

A new theory of sulphite pulping mechanism, as a result of research at the Pulp and Paper laboratory, Florida, may make continuous sulphite pulping a reality. Investigations have shown that there is a moving reaction at the interface of the wood chip surfaces and that this moves inwards towards the middle of the chip so that outer fibres are degraded before the centre of the chip is delignified. Chips shredded along the grain to 3 to 10 mesh size resulted in successful delignification, on cooking for 60-90 minutes at high temperature (140°C) and pressure (130 p.s.i.) under conditions similar to those which would be required for continuous digesting. Northern spruce and ammonium sulphite cooking liquor were used. Results to date show that neither screened yield nor quality of pulp were as high as can be produced by batch methods. The laboratory is now attempting to raise the cooking temperature to 170°C with 6% total and 2% combined sulphur dioxide in Nionel digesters. Main problems encountered so far are corrosion and auto-oxidation which in time causes buffering of NH_4HSO_3 at high temperatures.

American Cyanamid Expand Phosphate Production

Production capacity of phosphate fertilizers is to be increased at the Brewster, Florida, plant of American Cyanamid Company. The multi-million dollar expansion will provide facilities for producing 200,000 tons a year of granular triple superphosphates. In addition, a new coarser triple superphosphate and increased supplies of run-of-pile material will be available. New sulphuric acid capacity is also included in the expansion plans.

This summer Cyanamid doubled production capacity for phosphoric acid, and a considerable part of the expanded capacity will provide the raw material for manufacture of triple superphosphate. A modern system for control of air pollution will be installed and laboratory facilities are to be increased to handle a larger volume of sampling and analysis of products.

The new triple superphosphate plant is expected to be in operation in early 1962 and its output will be marketed throughout the U.S. and abroad. The project is part of Cyanamid's long-term programme of expansion, and the new production capacity will supply the ever-increasing demand for high analysis fertilizer.

Liberation of Beryllium by Sulphuric Acid

Nearing completion at Delta, Utah, is a 30,000 lb. a month plant, which will use a chemical process that starts with a sulphuric acid leach to produce a concentrate containing 97% BeO from finely divided Utah clay. The plant is that of United Technical Industries and its associate, Beryllium Corporation.

Process details of Technical Industries technique have not yet been revealed, but investment costs are expected to be about $86,000 per daily ton of ore concentrate produced. Operating costs will be considerably less than present costs.

This promises to become an important use of sulphuric acid — probably of the order of 280,000 s. tons a year.

NORWAY

Orkla Grube Sulphur Exports

Sulphur exports by Orkla Grube AB. have declined by 14,000 tonnes (21.4%) to 51,000 tonnes in 1960. In 1954, exports by this company totalled 99,257 tonnes. The bulk of the company's sulphur output is exported to Finland and Sweden.

Orkla Grube obtains its sulphur from the treatment of cupreous pyrites with copper matte arising as co-product. The reduced output and sales of both sulphur and copper has adversely affected the company's profits.

Supplies to the home market of about 25,000 tonnes in 1960 appear to have been made wholly from stocks.

Orkla Sulphur Exports

'000 tonnes

	1960	1959
Finland	13.0	21.4
Spain	—	5.0
Sweden	38.0	38.8
Others	0.5	0.2
	51.5	**65.4**

AUSTRIA

Decline in Use of Spent Oxide

Production of spent oxide is declining in Austria as the principal gas works, such as the main Vienna Gas Works, are abandoning the manufacture of coal gas and 95% of the country's gas supplies are now in the form of natural gas or refinery gas. In consequence many small gas works throughout the country have now ceased to exist.

A small amount of spent oxide is obtained at the Vienna Gas Works which still uses some coal primarily for production of coke. It is sold to Osterreichische Stickstoffwerke AG. for sulphuric acid production.

Spent oxide obtained at the coking plant at the large steel works of Voest is used for sulphuric acid production at the plant of the nearby nitrogen phosphate and fertilizer factory. In 1960, some spent oxide continued to be imported into Austria.

		Value—Austrian Sh.
Production ...	2,200 tonnes	
Imports ...	687 tonnes	98,000

Steirische Chemie's CS_2 Production Falls

Sales of carbon disulphide, the main product of Steirische Chemie AG. of Kapfenberg, in 1960 are reported to have declined 4%. This decline is due to the difficulties experienced during 1960 by the company's main customer, Zellwolle Lenzing, which produces the viscose fibres, sales of which have fallen by 2%. Export sales of carbon disulphide by Steirische Chemie, however, have increased by 45%. The company expects production in 1961 to continue at the same level as in the previous year but believes that sales and demand will decline. Steirische is planning to expand production of its other products, notably sodium sulphate, and to introduce new products.

U.S.S.R.

Sulphur and Acid Industry Developments

Near Rudnyy, in Kazakhstan, a concentration plant for sulphide ores, which is described as "unique," is under construction. When completed it will have a capacity "unequalled in the world." The ore treatment section, according to reports, will be capable of handling 12 million tons of ore annually; it will be in operation by early 1962.

By analogy with the existing plant at Rozdolski* the new project when completed can be expected to produce over 3 million tons of high purity sulphur. At Gaurdak in south-east Turkmenistan, where a small sulphur ore refining plant is in operation, a new mine has been taken into full production.

In 1960, Russia's production of sulphuric acid amounted to 5.4 million tonnes compared with 5.1 million tonnes in 1959. In the first half of this year, acid manufacture is claimed to have increased by 5% over that of the same period in 1960 to 2.8 million tonnes, corresponding to an annual rate of 5.6 million tonnes. Although sulphuric acid production has increased, output has failed to keep pace with the expansion of Soviet chemical industry.

More sulphuric acid plants are being constructed in the U.S.S.R. to meet the country's requirements. Now completed is the sulphuric acid section of the chemical works under construction in Kedaimiai, Lithuania. Steam from the sulphuric acid plant will be utilized by the power station also being erected at the site.

POLAND

Natural Gas Deposits

Recently discovered deposits of natural gas in south-east Poland are comparatively small. At one of these field the gas contains an average of 1.2 gramme per cubic metre of hydrogen sulphide. Removal of hydrogen sulphide will be carried out at the gas well-head and for this purpose a desulphurizing unit is being erected in which the monoethanolamine process will be employed. The sulphur so recovered will be delivered for sulphuric acid production and the sweetened gas will be piped to main distributing centres.

* Sulphur No. 35, 1961, August, Page 22.

Jefferson Lake Sulphur Company Reduced Sulphur Sales During First Half 1961

A 32% decrease in sales of Gulf Coast sulphur in the first half of 1961 compared with the first half of 1960 is attributed by Jefferson Lake Sulphur Company to the closure of the Manderson, Clemens and Starks plants in the last quarter of 1960, the effect of supplying consumers in California and the Pacific North-West from the Peace River plant of Jefferson Lake Petrochemicals instead of the Gulf Coast plants, and the carry over to the third quarter of 1961 of export shipments originally planned for the second quarter.

The average price received for sulphur f.o.b. Gulf Coast mines was 95 cents per long ton less than in the first half of 1960.

Canadian Facilities

Production of sulphur at the Peace River plant has remained constant but tonnage sales for the first half of 1961 are reported to be 61% greater than the first half of 1960.

Construction of Jefferson Lake Petrochemicals' plant complex in the East Calgary field in Alberta will be completed by December of this year. Planned daily production is 100 million cu. ft. of pipeline gas, 2,000 barrels of liquid products, and 870 long tons of sulphur.

At Coleman, Alberta, construction of a plant to convert concentrated hydrogen sulphide to sulphur is also scheduled for completion by December. Hydrogen sulphide will be supplied from the gas processing plant of Saratoga Corporation, a subsidiary of Westcoast Transmission Co. Ltd. Production capacity will be 377 long tons of sulphur a day and initial production is expected to be approximately 275 longs tons a day.

Financial

Gross profit of the parent company for the period under review was $1,242,661. Net income for this period was $323,797, an increase of 117% over the figure for 1960 ($149,373).

Gross sulphur sales of Jefferson Lake Petrochemicals totalled $394,193 in the first half of 1961.

Net earnings were $145,128, an increase of 283% greater than in the same period of 1960 ($37,853).

Gulf Sulphur Corporation Has Increased Sulphur Production

. . . continued improvement can be expected in all phases of our operations and we look to the future with confidence.

Robert H. Allen
President
Gulf Sulphur Corporation

THE twelve months to July 1961 are described as a period of significant accomplishment and progress for Gulf Sulphur Corporation. During this period, a complete plan of recapitalization was put in effect, important changes were made in mine personnel and daily production of sulphur was increased substantially.

Production

During the six months to June, average daily production has increased steadily from 500 tonnes in January to 875 tonnes in June. It is expected that this average will be maintained.

During this same period 103,000 tonnes of sulphur was shipped, resulting in a net profit of $200,000 before depreciation and amortization charges.

Recapitalization

A plan of recapitalization was completed by 30 June 1961, resulting in the exchange of 12,315,911 shares of common stock for $6,375,133 of debts and private royalties of $2.76 per ton of sulphur produced. This exchange* not only reduced current liabilities by $1,779,172, liabilities to principal stockholders by $554,461, and long-term debt by $4,041,500, but reduced total cost of producing and selling a ton of sulphur by $3.50. Long-term debt was reduced from $4,752,996 to $711,496 representing debenture of $669,000 still outstanding and $42,496 of equipment purchase contracts. Current assets at 30 June after recapitalization amounted to $2,086,000 as against liabilities of $1,289,000.

Asset Values

As an integral part of the recapitalization programme, a re-statement of asset values is being made, with effect from 1 January 1961. Until this has been completed, depreciation and amortization charges cannot be determined.

* Sulphur No. 33, April 1961, Page 46.

Montecatini Curtailed Sulphur Production in 1960 But Increased Output of Pyrites

In accordance with plans, Soc. Montecatini reduced its output of sulphur to 17,845 tonnes in 1960 (33,844 tonnes in 1959). This includes both the output at the company's Oran mines and that at the Stincone Mine of the associated Company Societa Miniere Apaforte, Pilaciocchi e Stincone. Actual ore production totalled 154,347 tonnes, mostly from mines in Sicily. During the same period, the report states, Italian sulphur output dropped considerably from approximately 122,000 tonnes to 80,000 tonnes, while world sulphur production in 1960 was about 9 million tons.

Pyrites

Montecatini produced 1,397,783 tonnes of pyrites during 1960, an increase of 34,178 tonnes. Overall production was satisfactory in spite of flooding and consequent damage to surface and underground mine installations.

Prospecting results in the Gavorrano, Rigoloccio and Niccioleta areas, where the deposits are of remarkable size and excellent quality, were satisfactory. Prospecting the Fenice Capanne area has also proved promising. Because of the world sulphur market situation, Montecatini has been investigating the exploitation of the Maremma pyrites as a source of iron. Pyrites from Maremma will be transported to a new plant at Scarlino-Follonica, where a new process patented by Montecatini will produce high purity iron and sulphur as by-product.

Sulphuric Acid

Sulphur recovered as by-product at Follonica will be converted to sulphuric acid in a modern, large-capacity plant to be built at the same site. Production costs of the acid, Montecatini states, will thus be competitive. It will be sold to consumers and also used by Montecatini itself, replacing acid now produced in plants which are nearing obsolescence. The company's output of sulphuric acid in 1960 was 1,237,449 tonnes (100% H_2SO_4) compared with 1,116,192 tonnes in 1959. The new sulphuric acid plant at Spinetta Marengo came into operation in 1960, and construction started at Porto Empedocle on a new facility for concentrated sulphuric acid which was due to be on stream by summer 1961.

Phosphate Fertilizers

During the year under review, Montecatini continued to improve phosphate fertilizer production. The company intends to maintain supplies of superphosphate for the domestic market. Some plants which had become obsolete were closed, and plants which are described as being " in a better geographical position " are being modernized to enable production costs to be brought into line with domestic and foreign sales prices.

In its report Montecatini notes that in the case of superphosphate sold in Italy, the Inter-Ministerial Committee on Prices has fixed the selling price at such a level as to discourage even the best equipped producers in the world.

Snia Viscosa's Results Reflect Transformation in Operations

WHAT is described as a " deep transformation " has taken place in the operations of Snia Viscosa (Società Nazionale Industria Applicazioni Viscosa) of Milan during the past few years, and particularly in 1960. This transformation is reflected in the results for the group.

Overall production of man-made fibres only shows a small increase: 109.5 million kilos in 1960 against 107.4 million kilos for 1959. A more detailed analysis shows an increase of 12.4% for rayon filament and a decrease of 9.6% for staple fibre. Production of other cellulosic fibres increased by 13.3%. In the field of proteic and synthetic fibres an increase of 13.2% was recorded for Merinova and of 44.6% for synthetic fibres chiefly of polyamidic origin.

Caprolactam Development

Recent developments by Snia Viscosa's research centre include a process for the production of caprolactam in respect of which licences have been granted to several foreign groups.

Work has been carried out on the manufacture of plastics based on caprolactam, and a new polymerisation plant is being constructed.

Production of Lilion has increased and the quality of the material has been improved. Construction of a new polymerisation plant and of a new staple fibre will shortly be completed. Towards the end of 1960 production was started on an industrial scale of Velicren, a polyacrylic fibre.

A plant for the production of carbon disulphide from methane was completed in 1960.

Associated Companies

S.A.I.C.I. (Società Agricola Industriale per la Cellulosa Italiana) increased production of " noble " cellulose by 16.5%, of " sodic lye " by 46.4%, of liquid chlorine by 48.9% and of sodium hypochlorite by 17.1%. Plans are well advanced for a polyvinyl chloride plant.

Preparation of Cisafan (transparent viscose) is at the preparatory stage at the Naples plant of Cisa Viscosa (Compagnia Industria le Società per Azioni per le Produzioni Viscosa). It is expected that output

will soon be capable of fulfilling market requirements.

Snia Viscosa's Indian associate, South India Viscose, has opened a plant for the production of staple fibre, sulphuric acid and carbon disulphide. Rayon production is expected to start soon.

Balance Sheet

Net profit for 1960 was Lire 4,342,713,188, compared with Lire 2,960,437,428 for the previous year. Gross profit on sales for 1960 is Lire 14,617,035,390, an increase of Lire 3,038 million on 1959. Lire 6,000 million was allocated to depreciation in 1960 compared with Lire 4,500 million in the previous year.

Total dividend is Lire 3,936 million (Lire 2,745 million for 1959), representing Lire 140 for each of the 22,875,000 shares entitled to full dividends and Lire 70 for each of the 10,484,375 shares entitled to dividends from 1 July 1960.

London Issue Announced

Sponsored by Hambros Bank and Credito Italiano of Milan, an application has been made to the London Stock Exchange for quotation of the entire Ordinary and privileged share capital of Snia Viscosa. Ordinary share issue at present is Lire 30,291 million at Lire 1,200 each, privileged share issue is Lire 9,150 million at Lire 1,200 each, and preference share issue is Lire 591 million at Lire 1,200 each.

Previously, only a limited number of Ordinary shares have been quoted in London, but in several European stock exchanges it has been possible to deal fairly freely in both Ordinary and privileged shares.

As with the recent Montecatini introduction, arrangements have been made for introducing special deposit certificates in the near future.

Snia Viscosa has close connections with Courtaulds. There are boardroom ties and in addition Courtaulds are believed to be one of the largest individual shareholders in Snia Viscosa. In the last decade, however, Snia Viscosa has shown a much greater growth rate than Courtaulds.

S.N.P.A. Exported Over Half of 1960 Sulphur Output

HAVING completed its basic development programme for exploiting the Lacq natural gas deposit, Societé Nationale des Petroles d'Aquitaine, is now, according to the annual report for the year ended 31 December 1960, pursuing a programme of expansion in its other activities. The company has continued its explorations in France and North Africa and the Sahara, and is participating in explorations in the North of Spain.

Production

At Lacq the number of gas wells has been brought to the designed total of 33 and during the second quarter of 1960 re-equipment of the oldest wells was started. Examination of the tubing recovered showed that this had stood up well to the corrosive action of the gas. It was concluded that the use of uniform tubing and the larger diameter will allow increased production and greater economy of operation. The yield at wells, the output of which had been poor, has been boosted by acidification and results in most cases have been satisfactory. Reserves have been confirmed at some 200,000 million cubic metres. At the Lacq treatment plant 15 million cubic metres of gas were handled daily by the end of 1960, when the fourth stage of the installations, including two new desulphurization units, came into operation and work on the plant, which will raise daily production capacity to a maximum of 22 million cubic metres of gas and average 20 million cubic metres minimum were well advanced by the end of 1960. Output of gas from Lacq in 1960 amounted to 4,116 million cubic metres compared with 2,253 million cubic metres in the previous year, an increase of 83%.

	1960	1959
Pure gas (million m³) ...	2,701	1,352
Sulphur (tonnes) ...	790,500	426,400
Butane ,, ...	47,500	22,400
Propane ,, ...	36,800	18,300
Petrol ,, ...	150,000	76,500
Residues ,, ...	12,200	6,700

Sulphur Production and Sales

Sulphur production has also increased markedly. Sales of sulphur amounted to 686,000 tonnes of which about one-half has been exported, principally to Western Europe; Great Britain and Western Germany were the principal purchasers. Sulphur exports and a part of the deliveries to the home market were transported by sea. S.N.P.A. chartered 314 ships with a total tonnage of one-half a million tonnes. At the loading facilities at Bayonne additional mechanical equipment has been installed which has improved their efficiency and increased their flexibility.

In order to meet the demands of customers with regular deliveries, sulphur stocks have been increased, and these amounted to 147,000 tonnes at the end of 1960.

Financial Results

Gross revenue in 1960 totalled NF 348 million compared with NF 178 million in 1959. For 1960 a dividend of NF 25 has been recommended.

Reserves	NF 149.6 million
Revalued property	NF 60.3 million
Reserve for renewing stock	NF 3.1 million

The administrative counsel proposes eventually to augment S.N.P.A. capital by incorporating part or all of the reserves.

New Appointments

M. Andre Blanchard has resigned as president; M. Jean-Paul Delcourt is the new president, and M. André Bouillot has been made a director.

Ets. Kuhlmann's Sulphuric Acid Facilities Satisfactory Operations

MAIN impact on the affairs of Etablissements Kuhlmann in 1960—as reviewed in the company report—was made by increases in costs of raw materials, salaries, railway charges and freights, the profound effect on the economy as a whole of increased imports into France from the other E.E.C. countries and, at the same time, a reduction in prices.

Sulphur

Sulphuric acid production was increased by 16% and at the company's Belgian plant a contact sulphuric acid unit came into operation in 1959.

The new contact sulphuric acid plant at Villiers-Saint-Paul, which was built in 1959, has operated satisfactorily and is supplying the requirements of the nearby works of Compagnie Francaise des Matieres Colorantes, and also customers in the Paris region. Sodium sulphate capacity has been increased at the Loos works by construction of a new furnace; an extension to the high purity sulphate unit has also been effected.

During 1960 a third furnace for sodium sulphate has been installed at the Estaque plant. Capacity at the sodium hyposulphite plant at La Madeleine has also been increased to meet the demand in French export markets.

Phosphoric Acid

Production of phosphoric acid at the Wattrelos, France, and Rieme, Belgium, plants has been raised by 19%. A fall in demand for sodium phosphate destined for the detergent industry was experienced, while production of ammonium phosphate, destined for export, has been increased.

A new ammonium phosphate plant was commissioned in 1960 at Rieme, thus doubling capacity for this fertilizer. While production of phosphorus has been somewhat lower in 1959, there has been an overall increase in production of phosphoric acid derivatives.

At the Epierre works a unit for production of phosphoric anhydrite incorporating the most up-to-date techniques and equipment has been installed.

Overseas Activities

In Brazil, Companhia de Superfosfatos e Productos Quimicos has expanded sulphuric acid production by the installation of a second unit having a daily capacity of 200 tonnes a day; the unit went into operation in 1960.

In Morocco, production of superphosphates by Societé Cherifienne d'Engrais et de Produits Chimique totalled 77,530 tonnes, and was slightly lower than output in 1959. Deliveries of superphosphates and fertilizers fell by 15% but sales of chemical products rose over those of the preceding year.

Finance

A dividend of NF 5 per share of NF 50 has been paid for 1960. Turnover rose to NF 632,966,855, an increase of 8.84% compared with 1959. Export sales have increased by 36.8%. In 1960 a number of plants were re-valued by NF 1,535,478.39 and the overall value of plants, etc., is now NF 94,200,246.41. Profit after all charges and amortizations is NF 17,450,538.52.

Algemene Kunstzijde Unie Reports Booming Rayon Tyre Cord Demand in 1960

DEMAND for rayon tyre yarn in 1960 was so great, according to the annual report of Algemene Kunstzijde Unie N.V. (A.K.U.), that it was barely possible to satisfy it. As a result, production facilities have been extensively modernised and the enlargement of facilities for processing rayon yarn into tyre cord and fabric, announced in the Annual Report for 1959, is nearing completion.

Deliveries from Stock

In contrast, shipments of rayon textile yarn remained below the 1959 level. In both years delivery was made from stock. A.K.U.'s policy has been to maintain a standard of quality which will meet the demands of an increasingly critical market.

The trend of demand for rayon staple is becoming increasingly concentrated on special types, such as coloured and crimped fibres.

Consumption of Enkalon (nylon-6) textile yarn continues to increase. There were some indications that the market for stretch yarn, which for some years has been firm, was developing less strongly. However, other techniques for processing synthetic yarns are gaining in importance and should open new fields of application.

Preparations are being made for the production of Enkalon tyre yarn, but A.K.U. does not expect substantial sales in the near future as the continuous improvement in properties, combined with easy processability of rayon and tyre yarn, is expected to enable the latter to maintain its position in forthcoming years.

Sales of Akulon, a nylon raw material for the plastics industry, increased in 1960. Verenigde Plastic-Verkoopkantoor N.V., which markets Akulon, has completed a sales service laboratory at its offices in Zeist.

Research and Development

New research facilities, which became available in 1959, have led to the development of new methods of decreasing the cost of rayon textile yarn and rayon tyre yarn. Development of special synthetic yarns for tyres, fishing nets, cables and other products is proceeding. A.K.U. research departments are co-operating with the Dutch Government in investigating the use of nylon fabrics for water control projects.

Associated Companies

In January 1961 A.K.U., in association with Vereinigte Glanzstoff-Fabriken AG., decided to assist Century Rayon, a rayon manufacturing company in India affiliated to the Birla Group, to construct and install a rayon tyre plant at Kalyan, near Bombay.

In Mexico a nylon-6 plant is being constructed by Fibras Quimicas S.A. and it has been decided to start construction of a nylon-6 plant in the U.K. American Enka Corporation, an affiliated company, plans to increase nylon yarn production capacity by 70%. Vereinigte Glanzstoff-Fabriken has invested substantial sums in fully synthetic products and part of its enlarged Perlon capacity will be housed with J. P. Bemberg AG.

Financial

Net income for 1960 was Dfl. 9.3, an increase of more than 10% over 1959, which is attributed principally to higher operating income from the Netherlands plants. Price reductions in certain raw materials, improvements in plant efficiency and expanded production capacities have more than offset the higher cost of wages, salaries and expenditure for employee benefits, and have allowed lower production costs for almost all products.

Retained earnings were Dfl. 17.4 million (Dfl. 16.1 million in 1959) and the dividend on ordinary shares was 17% (16%). At the end of 1960 the number of employees was 13,600 (12,650).

Board Changes at Freeport Sulphur

New president of Freeport Sulphur Company is Robert C. Hills. He succeeds Charles A. Wright who is now vice-chairman of the board. The chairman is Langbourne M. Williams.

Previously, as executive vice-president since 1950, Mr. Hills has been in charge of Freeport's present five sulphur-producing properties and was responsible for the construction and start up in April 1960* of the world's first off-shore sulphur mine at Grand Isle, Louisiana. He is also president of Freeport Nickel Company.

Two new members of the Freeport board of directors are Richard Wells and Thomas R. Vaughan, Mr. Wells is executive vice-president of the company and chairman of National Potash Company. Mr. Vaughan is vice-president and general counsel.

Board Changes at Jefferson Lake

Mr. Jeff D. Collins has been appointed vice-president-director of sulphur sales for Jefferson Lake Sulphur Company at the company's newly-opened sales office in New York City. Mr. Bradlee V. B. Postell has been appointed vice-president-director of corporate development and expansion, operating from Houston, Texas.

* Sulphur No. 29, May 1960.

Statistical Appendix

U.K. SULPHURIC ACID CONSUMPTION

tons 100% H_2SO_4

TRADE USES	1956	1957	1958	1959	1960
Acids—Organic and miscellaneous	*	*	*	*	37,608
Accumulators	10,391	11,128	12,015	12,484	13,660
Agricultural purposes	7,334	5,608	8,746	7,219	13,864
Bichromate and chromic acid	16,116	19,738	18,168	19,501	22,687
Bromine	12,240	12,800	12,181	16,642	23,464
Clays (Fuller's Earth)	10,859	9,670	10,357	10,901	12,293
Copper pickling	3,013	2,846	2,144	2,334	2,404
Dealers	12,750	11,964	11,235	15,472	13,423
Drugs and fine chemicals	16,699	19,098	18,899	19,957	20,417
Dyestuffs and intermediates	76,597	86,852	75,460	98,630	104,485
Explosives	20,292	15,237	11,404	12,076	9,493
Export	4,412	5,212	3,199	2,837	9,554
Glue, gelatine and size	468	516	505	439	532
Hydrochloric acid	61,200	58,195	52,858	50,356	53,418
Hydrofluoric acid	12,756	10,702	10,731	13,177	14,707
Iron pickling (including tinplate)	120,040	124,478	112,651	120,323	137,395
Leather	4,840	5,177	4,578	4,282	3,882
Lithopone	15,992	14,620	11,727	13,742	13,457
Metal extraction	3,643	3,396	2,660	2,979	2,608
Oil refining and petroleum products	62,546	60,733	55,542	64,804	77,075
Oils (vegetable)	8,905	8,101	10,983	7,726	9,281
Paper, etc.	6,517	5,592	5,572	7,335	9,494
Phosphates (industrial)	509	643	403	2,607	4,081
Plastics, not otherwise classified	39,702	35,088	40,938	48,977	65,267
Rayon and transparent paper	268,233	278,610	240,165	259,549	278,087
Sewage	10,031	10,229	10,166	12,827	12,572
Soap, glycerine and detergents	76,863	98,589	117,907	118,373	124,828
Sugar refining	826	701	686	827	831
Sulphate of ammonia	299,824	317,310	294,302	272,077	294,112
Sulphates of copper, nickel, etc.	26,758	24,767	15,424	24,620	20,670
Sulphate of magnesium	1,192	1,257	140	173	181
Superphosphates	520,050	543,578	538,081	568,428	621,451
Tar and benzole	24,857	30,275	30,899	21,061	23,837
Textile uses	18,969	14,952	10,679	17,402	16,310
Titanium dioxide	273,646	314,306	322,119	401,613	467,745
Unclassified	199,426	209,092	194,673	204,026	202,977
TOTAL	**2,248,496**	**2,371,060**	**2,268,197**	**2,455,776**	**2,738,150**
	* Included under unclassified				
Production total	2,251,180	2,335,891	2,241,146	2,428,504	2,701,374
Chamber and tower	546,026	528,716	482,670	405,673	439,117
Contact	1,705,154	1,807,175	1,758,476	2,022,831	2,262,257
Raw materials consumed					
Pyrites	393,696	366,908	327,692	319,315	352,964
Spent oxide	252,224	263,560	242,674	221,779	250,206
Sulphur					
Imported	261,599	289,109	277,625	327,785	377,731
Recovered H_2S and F.C.	32,410	43,564	44,752	55,724	65,567
Zinc concentrates	187,933	158,858	152,217	191,598	197,521
Anhydrite	697,732	737,114	749,045	748,032	760,089

U.S. ELEMENTAL SULPHUR SUMMARY

	1st half 1960	2nd half 1960	1st half 1961	Difference 1st half 1961	% Change
TOTAL					
Production	**2,779,844**	**2,886,940**	**3,020,035**	**+240,191**	**+ 8.6**
Frasch	2,430,159	2,512,603	2,603,700	+173,541	+ 7.1
Recovered	349,685	374,337	416,335	+ 66,650	+19.0
Apparent Domestic Consumption	**2,481,802**	**2,324,314**	**2,503,703**	**+ 21,901**	**+ 0.9**
Apparent Sales					
Frasch	2,545,121	2,538,797	2,442,372	−102,749	− 4.0
Recovered	379,812	374,988	419,373	+ 39,561	+10.4
Total Stocks	**3,804,865**	**3,778,023**	**3,936,313**	**+131,448**	**+ 3.5**
Frasch	3,694,746	3,668,556	3,829,884	+135,138	+ 3.7
Recovered	110,119	109,467	106,429	− 3,690	− 3.4
Change in Stocks	**−145,089**	**−26,842**	**+158,290**		
Frasch	−114,962	−26,190	+161,328		
Recovered	− 30,127	− 652	− 3,038		
Total Imports	**414,188**	**327,427**	**398,822**	**− 15,366**	**− 3.7**
Total Exports	**857,311**	**916,895**	**756,864**	**−100.455**	**−11.7**

* June 1961 figure estimated

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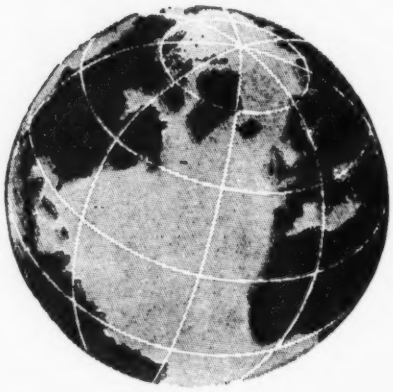

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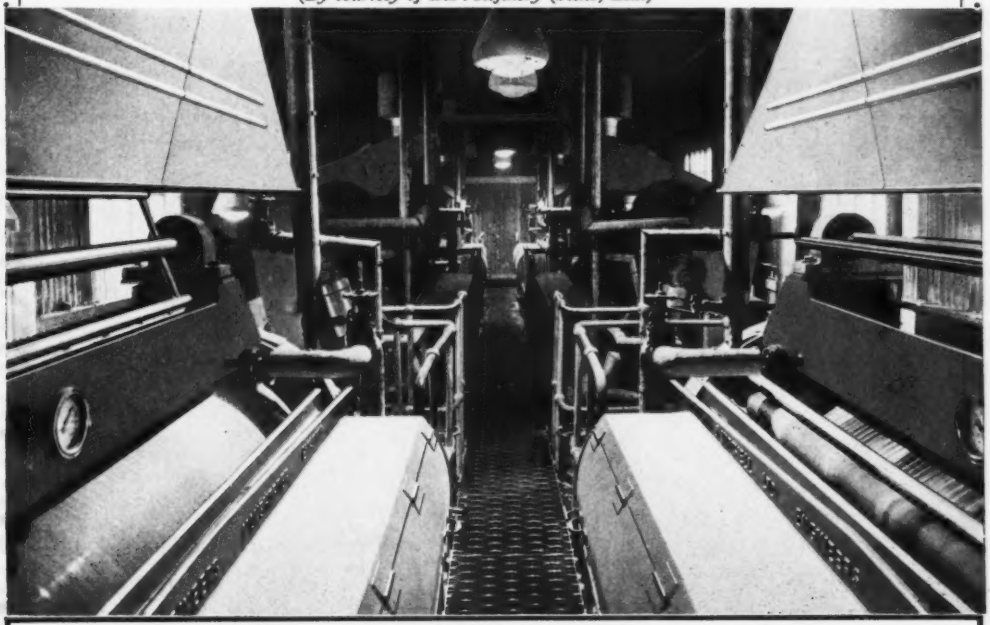

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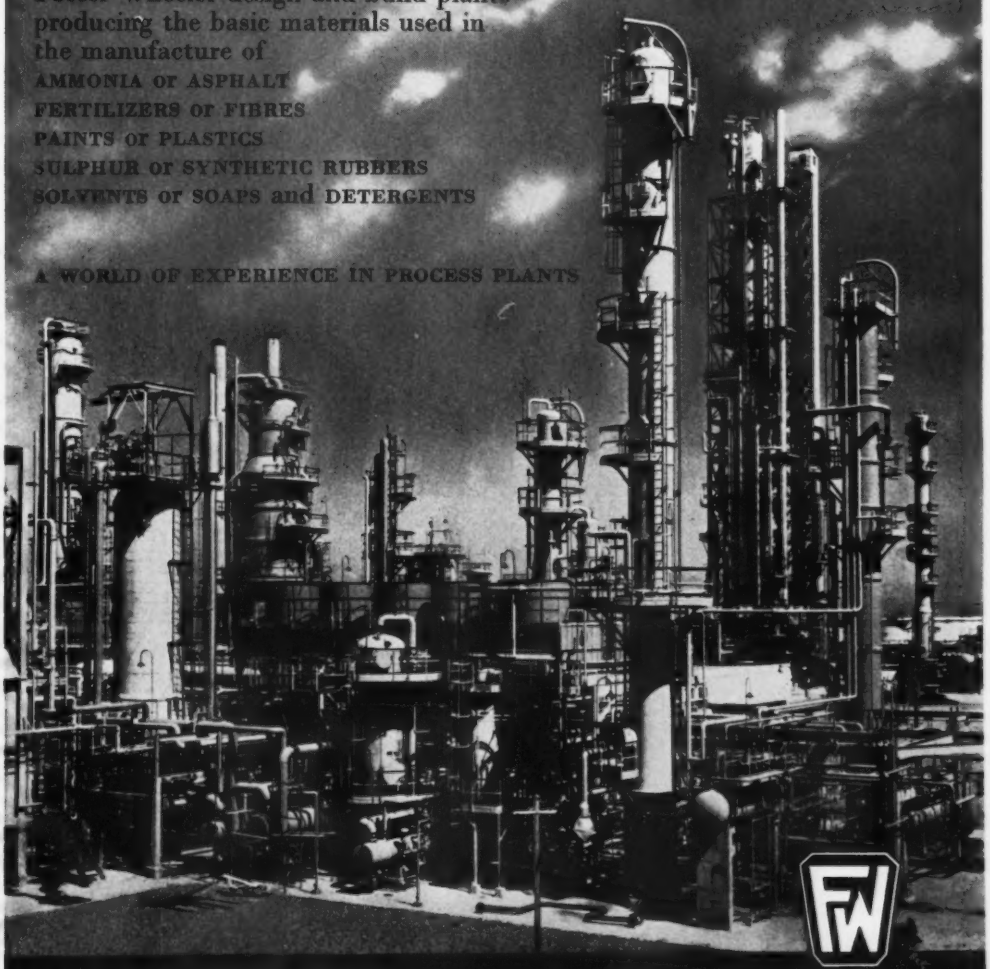

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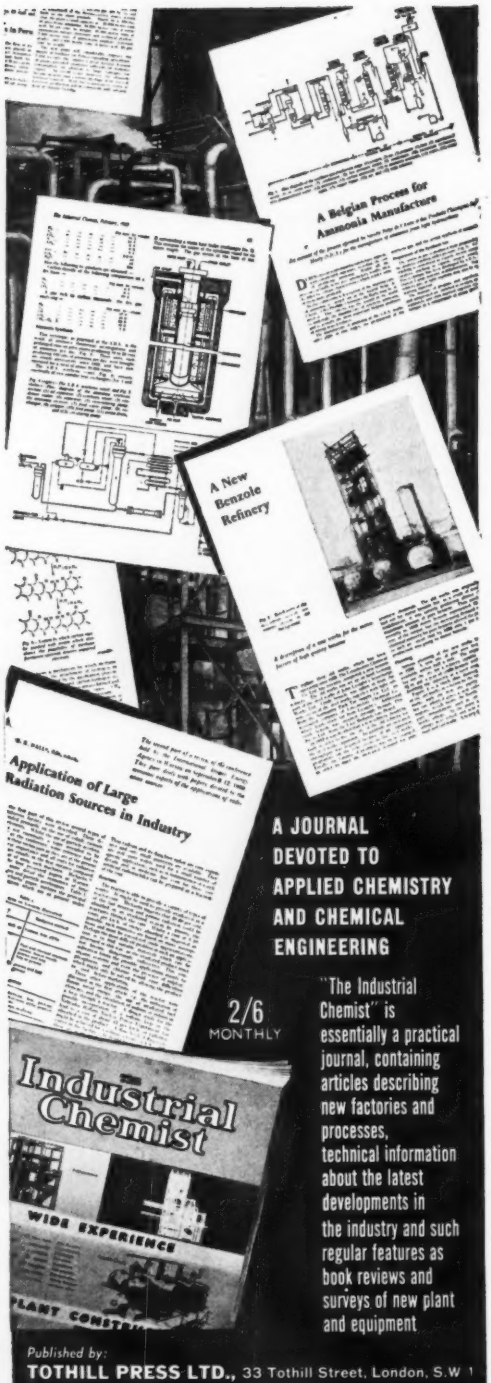
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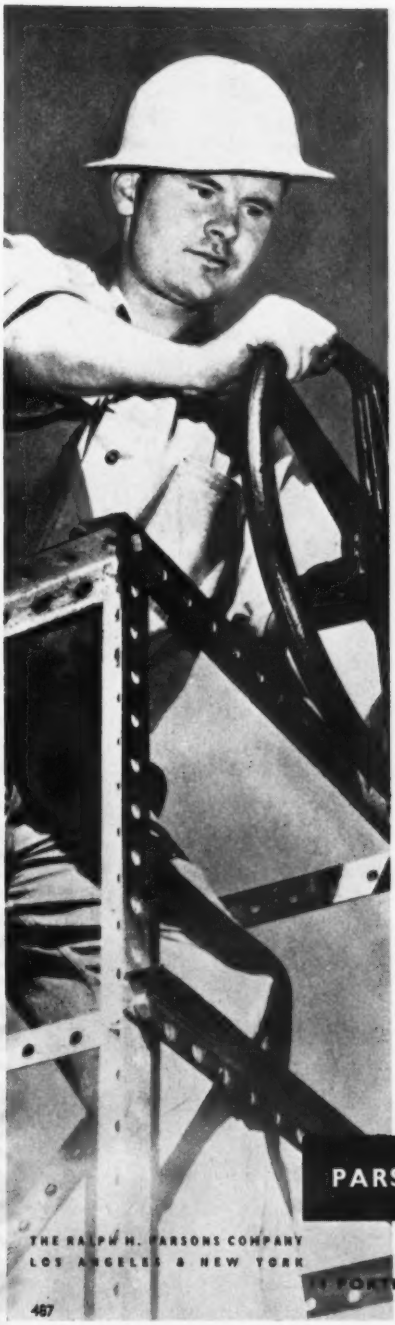

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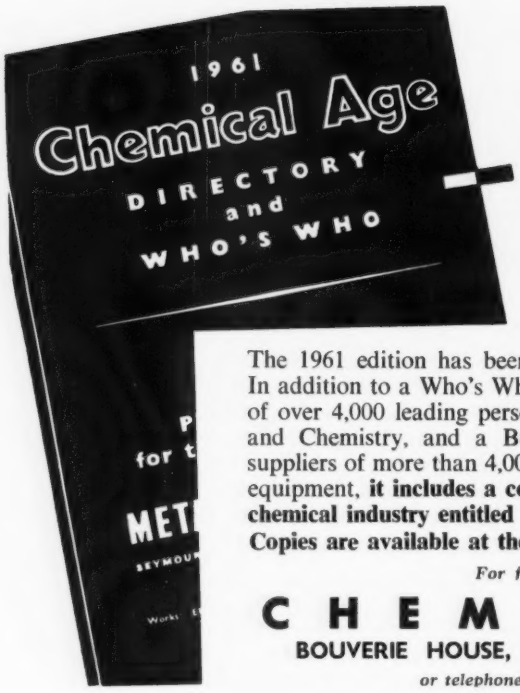

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